Knowledge & Scientific News

A MONTHLY JOURNAL OF SCIENCE.

Conducted by MAJOR B. BADEN-POWELL, F.R.A.S., and E. S. GREW, M.A.

VOL. III. No. 18. [NEW SERIES.] MAY, 1906. [Entered at Stationers' Hall.] SIXPENCE NET.

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Astronomical Photography.

Hints to Amateurs Regarding Appliances and Methods of Working.

By ALEXANDER SMITH.

II.

Adapting Telescopes for Photographic Purposes.—Both refracting and reflecting telescopes may be utilised for photographic purposes, but unless the former type of instrument is specially corrected for this kind of work the chemical and visual foci will not be coincident. The difference may be ascertained by making a number of short exposures, and noting the plane at which best definition is obtained. Photographic achromatism is sometimes secured by altering the distances between the crown and flint lenses, and sometimes by using a third lens specially corrected for the purpose. Triple object-glasses suitable for both visual and photographic work are now procurable, but are very expensive. The reflector is, however, the type of instrument which appeals to the ordinary amateur, who is desirous of taking up astronomical photography, as perfect achromatism is secured at a comparatively small cost. To adapt a well-mounted clock-driven instrument of this class for such work, few additional appliances are required. A guiding telescope—either reflector or refractor—will have to be provided, and the aperture should preferably be not less than four or five inches. A plate-holder with suitable carrier will also be required. The latter may be attached to the telescope with a piece of brass tubing of the requisite diameter to slide firmly into the eye-tube. To one of its ends a flange is fitted, by means of which the tube is attached by screws to the carrier, the necessary focussing adjustment being made by the rack of the telescope.

With large reflectors, used solely for photography, a flat is usually dispensed with, and the plate placed inside the main tube at the primary focus of the mirror. The plate thus practically takes the place of the flat, and is supported in a similar fashion by three thin pieces of steel. The plate-carrier is attached to a short length of stout brass tube, inside of which another tube, worked by rack and pinion, slides, and by which the final focussing adjustments are made. The dark-slide is fitted with a shutter, which folds back in the line of focus, where it is held in position by a spring catch. In some cases a flap-shutter is also fitted to the carrier, and is raised or lowered by means of two strings, a small weight attached to either string keeping it in position. In such equipments the mirror has usually a central aperture, through which the brighter objects on the plate can be directly examined with a small telescope, and, in the case of long exposures, it can also be ascertained by the same means whether any displacement of the speculum has taken place.

Enlarging Lenses.—With instruments, such as are generally to be found in the hands of amateurs, the discs of the sun, moon, and planets at the primary focus of the mirror are too small, particularly in the

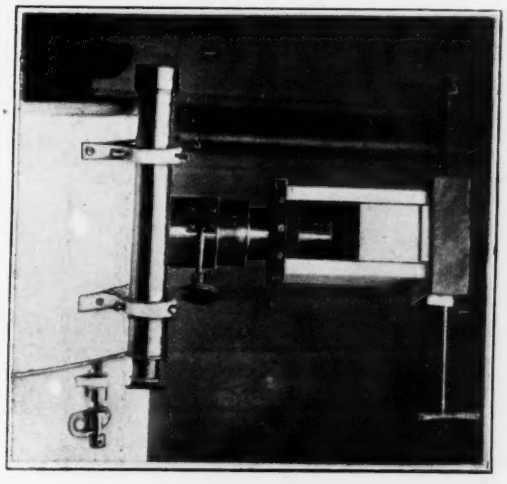

Fig. 3.

case of the planets, to exhibit much in the shape of detail, compared with the results which are obtained visually when an eye-piece is employed. At the same time it is astonishing how much detail can be shown by enlargements from such photographs, if the method afterwards described is adopted. It must, however, be conceded that a negative obtained by enlarging the primary image by a lens in the telescope will exhibit less of "grain" than if the image is directly transferred to a photographic plate and afterwards enlarged to the same dimensions.

Different forms of enlarging lenses may be successfully employed, the most popular probably being the "Barlow" and low-power positive eye-pieces. Very fine results may also be obtained with the negative components of telephoto lenses of the better class, which give a very flat field, and have the additional advantage that only a short extension of camera is re-

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quired. When it is desired to secure an enlarged photograph of the whole of the solar or lunar disc, the diameter of the lens must, of course, be at least equal to that of the primary image. To bring such lenses into use some form of camera is necessary. This can be attached to the eye-tube of the telescope in the same manner as the carrier previously referred to. Fig. 3, which is self-explanatory, shows the complete arrangement as used by the writer. The enlarging lens is fixed in a sliding tube, and, through the small door with which the camera is fitted, it can be moved nearer to or further from the plate to increase or diminish the amount of magnification, the focussing being accomplished by the rack-work of the telescope. For planetary work a screw similar to that previously described, and which is also shown in the figure, can be brought into use, and several exposures put on the same plate.

Shutters.—It will be found of great convenience for regulating the exposure if some form of shutter is attached to the eye-tube of the telescope. The type adopted should have a fairly large opening, work smoothly, and admit of giving "time" and "instantaneous" exposures. It should be fitted with a short length of brass tube similar to that described for the camera and plate-carrier. It may then be readily placed in position by sliding the tube into the end of the eye-tube which is next the flat, and, consequently, inside the telescope, the release being most conveniently effected by the usual pneumatic ball.

Driving-Clocks.—Many amateurs possess driving-clocks, but only a small proportion of these give sufficiently accurate results to enable their owners to take up photographic work in a systematic fashion. In some cases failure may arise from faulty construction of the mount. The polar axis may be too short to secure the requisite rigidity, or, what is a more common defect, the driving-worm, or pinion, as the case may be, is geared to too small a sector or circle. If a large sector

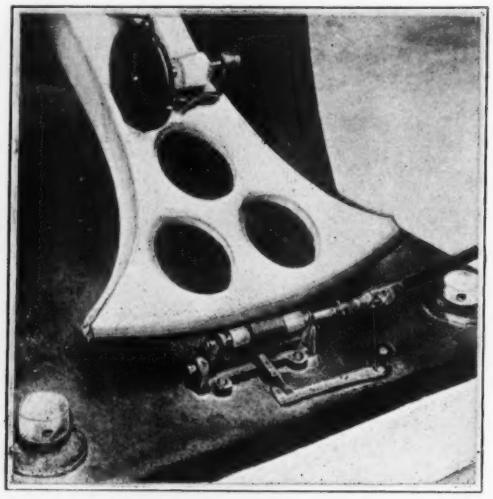

Fig. 4.

be used, very little strain is put upon the driving mechanism, and a greater measure of steadiness is at once secured.

Fig. 4 shows a sector of two feet radius with the driving-worm geared in position. It is very important that both the driving-worm and sector be accurately cut, otherwise slight movements of the image in the field will be apparent, although the motion of the clock may be perfectly regular.

In the matter of clocks, perhaps the most frequent source of trouble arises from the method of control, the ordinary frictional governor being uncertain in

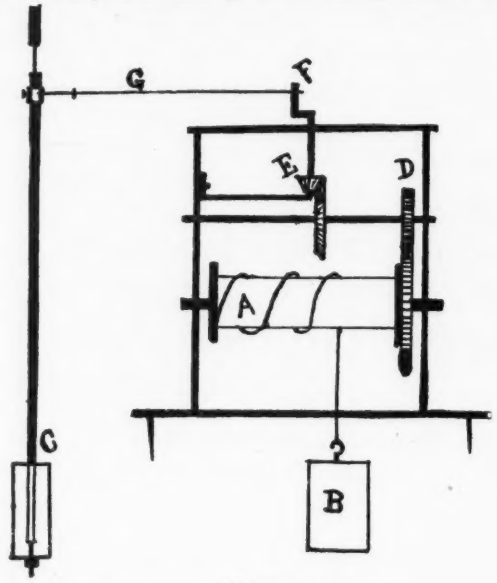

Fig. 5.

action, and, where accurate driving is essential, necessitating the introduction of electrical or other complications. For time-keeping purposes no method of control equals the pendulum for steadiness and reliability, but pendulum clocks in the ordinary form are quite useless for driving astronomical instruments, for the simple reason that they are fitted with escapements, which only admit of motion in the form of short though regular impulses, while for astronomical purposes the motion must be continuous. A clock can, however, be constructed whereby this result is obtained, and the advantages of the pendulum control at the same time secured. When the principle on which its utility depends is once understood the constructional details may be worked out in a variety of ways.

This principle may be made clear by referring to Fig. 5, which is intended to illustrate the action of a train of wheels on a single pendulum. A represents the clock barrel, B the driving weight, and C the pendulum. When the barrel rotates, motion is conveyed through the intervening wheel D to the bevel pinion E, and thence to the vertical spindle F, on the upper end of which there is fitted a short crank, which, in turn, communicates its motion through the connecting-rod G to the pendulum C, and as the latter swings backwards and forwards it regulates the rate of motion of the whole arrangement. A single pendulum will not give so satisfactory results as 3, and this is the minimum number recommended for a clock of the kind.

Fig. 6 is a photograph of a 3-pendulum clock of this description, which the writer found to give excellent results. On the top of the vertical spindle to which the crank is connected a train of small wheels terminating in a "fly" should be fitted, for the purpose of introducing a certain amount of flexibility in the drive between the clock and pendulums, in order that the oscillatory motion of the latter may be started and stopped

gradually and without shock, which would not be the case if the pendulums were rigidly joined to the rest of the driving mechanism.

A larger clock controlled by five pendulums, each 3 feet 3 inches long, was subsequently used, and when everything was properly adjusted the motion was so reliable and certain that when engaged in photographic work it was only necessary to examine the image in the guiding telescope at intervals of a few minutes. Notwithstanding extended trials with both types, it is difficult to express a decided opinion whether five pendulums give better results than three. A greater measure of steadiness appears to be secured by adding to their length than by increasing the number. Three must, however, as already pointed out, be regarded as the

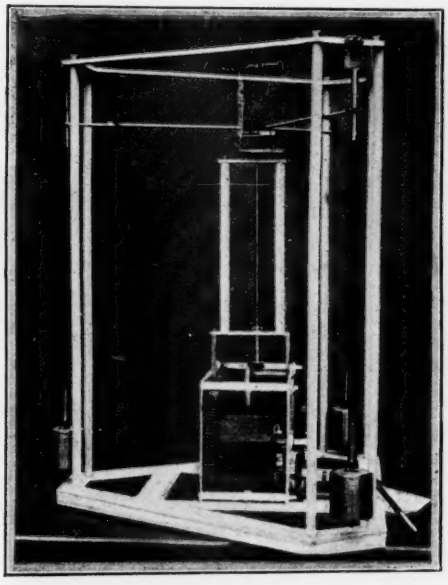

Fig. 6.

minimum, and their length should preferably not be less than three feet.

Having briefly described the various appliances which may be brought into use by those desirous of taking up astronomical photography, a few hints, based on the writer's experience, will now be given regarding methods of working.

Solar Photography.—In selecting plates for photographing the solar image the slowest brand procurable should be adopted; indeed, it may be pointed out as an invariable rule, that, where a sufficiently long exposure can be given with a slow plate, it should always be selected in preference to one of greater rapidity. Rapid plates do not give the same amount of delicate detail, neither do they admit of the same latitude in exposure. It is only in cases where very prolonged exposures are essential that their use becomes a necessity, at least so far as astronomical purposes are concerned. For solar work a good brand of lantern plate will probably be found to give the best all-round results. All plates should be backed with a suitable medium. No hard-and-fast rule can be laid down with regard to the duration of exposure, as this is appreciably affected by the position of the sun at the time the photograph is secured, but as a rough guide it may be stated that on a summer day with the sun placed in a clear sky, and the telescope stopped down to an angular aperture of f/60, an exposure of 1-40th of a second on a lantern plate will be found to be ample. In other words, if a telescope of a focal length of 10 feet is stopped down to an effective aperture of two inches, the exposure required will be about 1-40th of a second. If the primary image is enlarged by a lens, a correspondingly increased exposure must, of course, be given.

Lunar Photography.—In taking photographs of the moon, the beginner will soon discover that, in order to secure the desired amount of detail, the terminator requires a longer exposure than the rest of the illuminated disc, and that by giving exposures of varying duration the apparent age of the moon may be altered by several hours. At least three methods may be brought into use for getting over this difficulty. (1) A strip of cardboard, one end of which is similar in size and shape to the lunar terminator, may be introduced by the hand into the end of the telescope tube, and moved slightly backwards and forwards in front of the shutter for, say, two seconds, and rapidly withdrawn. It is to be understood that during the first part of the exposure the terminator only is to remain uncovered, and, if the shutter is closed after an interval of another second, the terminator will thus get an exposure of three seconds, and the rest of the disc one-third of that amount. (2) The plate may be given an exposure in the telescope suited to the terminator, and afterwards developed. A positive is then taken from the negative by contact, but during the exposure of the plate to the source of illumination a strip of cardboard, similar to that previously referred to, is brought into use, and moved slightly backwards and forwards over the image of the terminator during two-thirds of the total exposure, and then withdrawn. Another negative can be taken from the positive thus obtained either by contact, or, if a camera is used, an enlarged image may be obtained at the same time. (3) The plate may be exposed in the telescope as before, and the resulting negative afterwards reduced in density where necessary by the local application with a soft brush of a reducing solution, such as that known as "Farmer's" (Saturated solution of Ferricyanide of Potassium 1 part, Hyposulphite of Soda solution 1 to 5, 10 parts). If the method first referred to should not give the result aimed at, the defect may be removed by method No. 2 or 3, or all may be partly utilised in the production of a single negative.

If a lens is used in the eye-tube of telescope to enlarge a portion of the primary image, the illumination will be more evenly distributed, and the plate under such circumstances may be treated in the usual way.

Planetary Photography.—Unless a telescope of long focus is available, no very satisfactory photographs of any of the planets can be obtained, and even the best results, which have so far been secured compare unfavourably with the views which a comparatively small instrument presents to the eye of the observer. When dealing with such a small object, it is advisable to use an eye-piece in conjunction with the telescope to enlarge the primary image, and in the case of the brighter planets the aperture should be stopped down to reduce the intensity of the light with the view of being better able to regulate the exposure and development. Care should be exercised that these are not too prolonged, otherwise the small discs will be enlarged by the effect of halation, and all detail effectually obscured.

On the accompanying plate a few examples are given of planetary and lunar photography. With the exception of Fig. 10, where a 10¼ inch mirror of 6 feet

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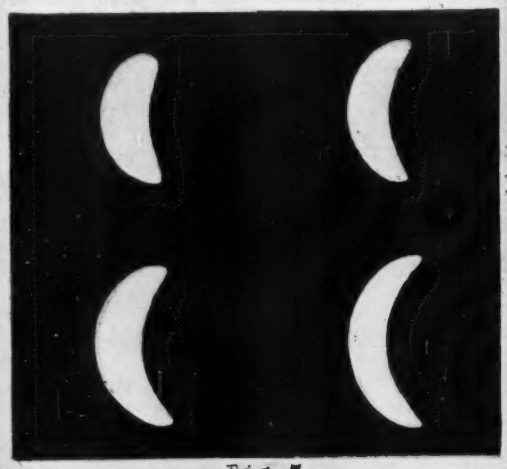

Fig. 7

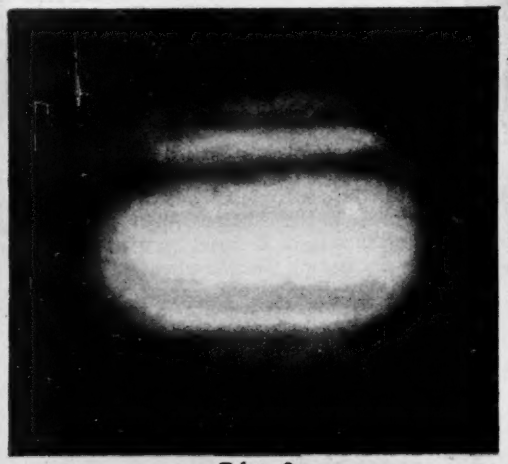

Fig. 8

Fig. 9

Fig. 10

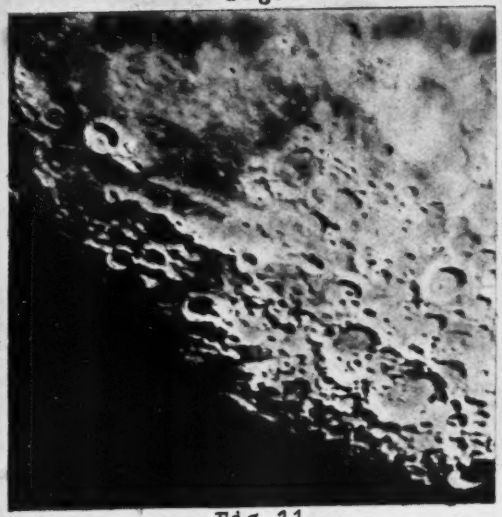

Fig. 11

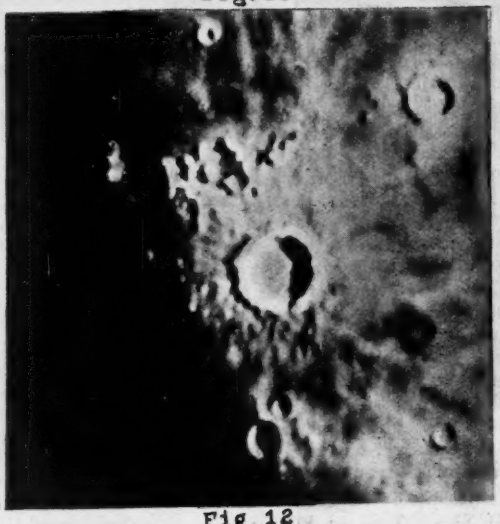

Fig 12

5 inches focus was used, all the photographs were taken with the same telescope, viz., a 12¼-inch reflector having a focal length of 10 feet. This instrument, which was formerly used by the writer, is now in the hands of Mr. Maclachlan, of Largs, who made the original exposures from which Figs. 8, 11, and 12 have been produced. It will be understood that all the original negatives were subsequently enlarged with the camera, and details of the method employed will be given in another paper.

Fig. 7 shows four photographs of the planet Venus, taken January 13, 17, 28, and 30, 1902, at the primary focus of the mirror. A slow plate was used, and the duration of exposure was about half a second. The images were afterwards mounted on a strip of glass and enlarged together.

Fig. 8 is a photograph of the planet Jupiter, the primary image in this instance being directly enlarged in the telescope wth a low-power Ramsden eye-piece. The exposure given was two seconds, and the plate developed with a solution of normal strength.

Fig. 9 was taken at the primary focus of the mirror, the lunar terminator receiving three times the amount of exposure given to the rest of the disc. (See method No. 1 referred to under "Lunar Photography.")

Fig. 10 was taken during the last phase of the lunar eclipse of April 11, 1903. The exposure in this case also was made at the primary focus.

In the production of Figs. 11 and 12 a Ramsden eye-piece was used in the telescope to enlarge a portion of the primary image, the exposure in each instance being 10 seconds. Those who are acquainted with lunar typography will readily recognise the regions depicted on the prints. Fig. 11 shows a portion of the terminator in the vicinity of the craters Bullialdus and Tycho, while Fig. 12 is a photograph of the well-known crater Copernicus and the surrounding region.

(To be continued.)

Simple Rule for Squaring any Number.

RULES for simplifying arithmetical calculations have often been published. The following simple method of squaring any number is somewhat interesting. It ought probably to be taught to beginners in connection with extraction of square root of which it is the converse, and an instructive exercise is afforded by squaring numbers by this method and verifying the correctness of the answer by long multiplication.

Suppose it is required to find the square of 5342·7198, the multiplications being carried to four decimal places; the process stands as follows :—

5342·7198	×	5342·7198		
5000	×	·5000	=	2500·0000
103	×	3	=	309
1064	×	4	=	4256
10682	×	2	=	21364
10684·7	×	·7	=	7479·29
10685·41	×	1	=	106·8541
10685·4	×	9	=	96·1689
10685	×	8	=	85·5·83
				28544654·8613

With a little practice, the successive lines of multiplication could be written down mentally without writing down the successive multiplicands and multipliers.

Numbers may be easily *cubed* or raised to any desired power by a kind of reversed Horner's process, very similar in principle to the above, but it is doubtful how far any further extensions of the method are suited for teaching purposes. G. H. B.

Spitzbergen and its Whale Fishery.

By T. SOUTHWELL, F.Z.S.

IT is only of late years that anything like order has been established in the classification of, or any important advance made in, our knowledge of the distribution and life history of the members of the important family of marine mammals known as the Cetacea, or whales and dolphins, and this especially applies to the whalebone whales of the northern hemisphere. It will hardly be believed that although the great Arctic Right Whale has been known since the year 1610 and many thousands of them killed, so rare is the skeleton of this animal and so difficult for various reasons to obtain, that it is still a desideratum to our National Museum; but owing to the establishment in Northern Europe and America of whaling stations for the pursuit and capture of the giant Fin Whales (Balænopteridæ), rendered possible by the discovery and perfecting of a mode of attacking them by explosive harpoons, the invention of Herr Foyn, a Norwegian whaler, abundant material has been rendered available for their study and accurate description. Still it is very remarkable how slow the general public is to appreciate this advance, and how singularly they fail to distinguish between the various distinctive branches into which the family is divided, even confounding, as will be seen below, those armed with teeth with those furnished with the remarkable appendage known as baleen, or whalebone, the feature on which the main division of the order is based, namely, Mystacoceti, or Whalebone whales, and Odontoceti, or those furnished with teeth.

Even in the writings of acknowledged authorities we sometimes meet with strange statements. For instance, in one text book we are informed that a Right Whale may produce several "tons" of whalebone, a most liberal allowance, and at the present price of £2,250 per ton, a very valuable asset; another authority states that the Right Whale, though found in the seas on both sides of Greenland, passing freely from one side to the other, is never seen so far south as Cape Farewell. The first statement is doubtless due to the intervention of one of those evil spirits specially allocated to the office of the printer, who wickedly substituted the word "ton" in the place of hundredweight; the second is probably an oversight, for its author was one of our most accomplished cetologists. That the Right Whale is (or was) found on both sides of Greenland is undoubtedly true, but as it never descends so far south as Cape Farewell it is difficult to understand how it can pass freely from one sea to the other. A charming writer and a leader in the world of science evidently never acquainted himself with the learned researches of Prof. Eschricht, for he adheres to the old belief that the whale formerly hunted by the Basques in the temperate regions of the Atlantic, through persistent persecution has retreated to the ice-fields of the Polar regions, whereas the species inhabiting these two areas are perfectly distinct.

Of late personally-conducted tours have been extended even to the icy regions of Spitzbergen, and, of course, the travellers to this No-man's Land have favoured their less adventurous brethren, by means of the public press, with the results of their peregrinations; and as the tourist is almost invariably furnished with a "Kodak," the illustrations to their articles are, as a rule, excellent,

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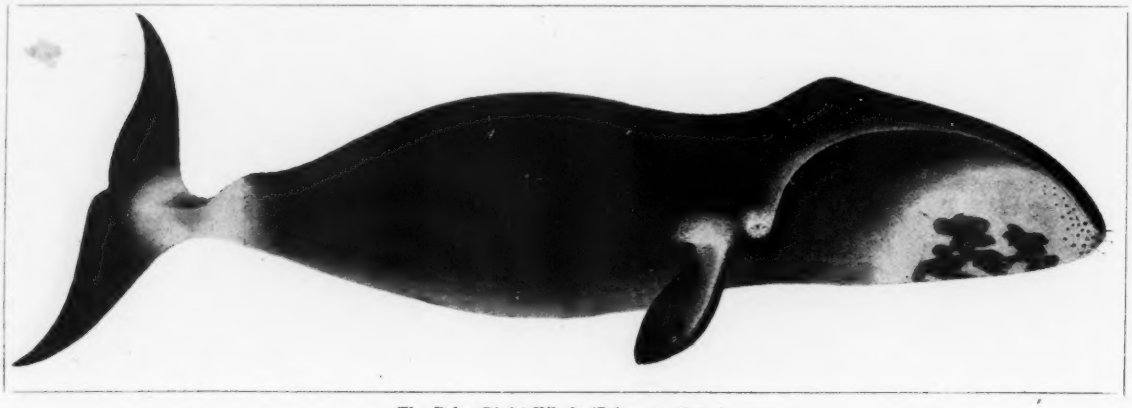
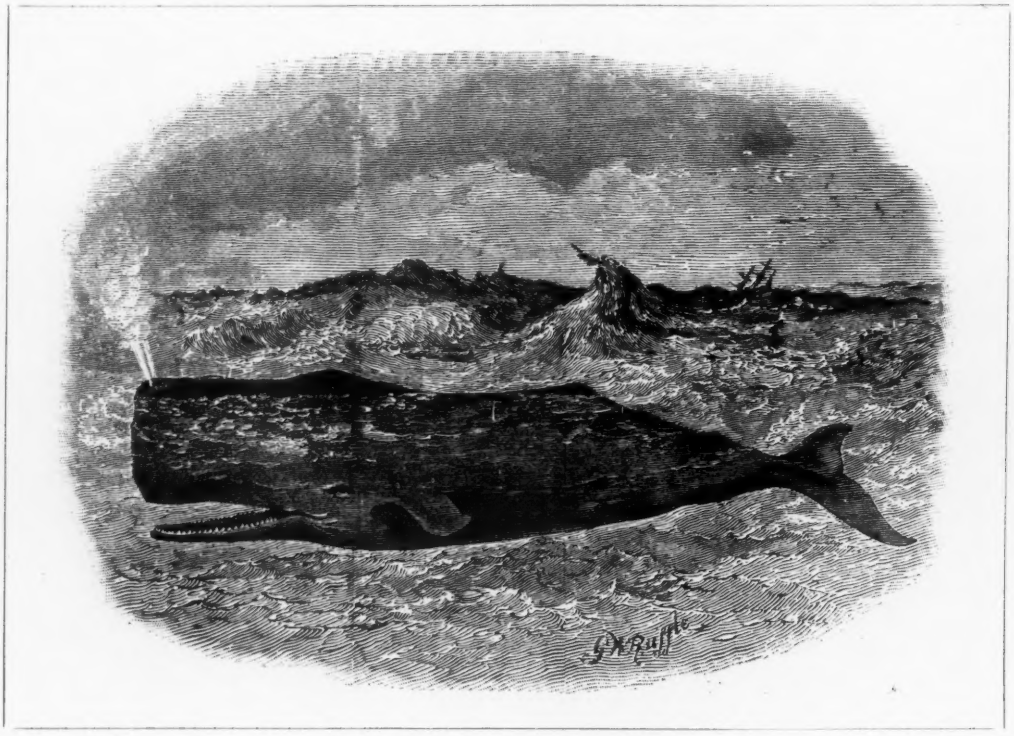
and give a fictitious value to the letterpress which is generally poor stuff enough. Two of these articles dealing with the Shetland Fin Whale fishery, one of which appeared in *Temple Bar* for September, 1905, and the other in the *Illustrated Sporting and Dramatic News* on the 9th of the same month, are all that can be desired, but in a third article, in another illustrated periodical, dealing with a visit to Spitzbergen, the author tells us that "the Sperm Whale, from which the best whalebone is obtained . . . is becoming rare!" It would be difficult, did one try, to embody an equal amount of inaccuracy in so few words.

But a more pretentious article, giving an account of a trip to Spitzbergen and of the whale fishery carried on there by the Norwegian vessels, has recently appeared in an old-established journal, which I have for many years read and admired for its usually short, crisp, and well-informed articles; but in this instance the editor has evidently been caught napping, so far as it relates to whaling, notwithstanding the fact that the editorial chair is usually considered quite other than conducive to somnolence. The author of the paper, after giving a brief history of the discovery of the group of islands and of the flocking thither of the various



The Polar Right Whale (*Balæna mysticetus*).
From an original drawing made from actual measurements by the late Capt. David Gray, of the S.S. "Eclipse," whaler.



The Sperm Whale (*Physeter macrocephalus*).
From Southwell's "Seals and Whales of the British Seas."

nationalities to participate in the capture of what he calls "the 'Right' or *Sperm* Whale," states that "the competing whalers had the good sense not to quarrel on the spot, and a fair division of the spoil (?) was accordingly arranged," a statement than which nothing could be farther from actual facts, as I think the following statistics will show.

Shortly after the discovery of Spitzbergen by the Dutchman, Barentz, in 1596, our countryman, Henry Hudson, followed the same course, and his glowing account of the vast numbers of whales and walrusses there to be found induced the English Muscovy Company, in 1610, to send out vessels for their capture; thereupon, under the impression that the Spitzbergen group formed part of Greenland, the Danish Government at once annexed them, but our James I., not to be behind in securing so productive a territory, lost no time in also asserting a claim to the islands and the adjacent seas, and although the assumption on which the King of Denmark based his pretensions proved not to be tenable, I am not aware that either claim has ever been officially renounced.

In 1612 the Dutch followed us to Spitzbergen, and for the next thirty years a fierce contention raged between the English, Dutch, Danish, and French crews for supremacy with varying success and frequent reprisals, the Dutch and Danes often calling in vessels of war to their assistance, whilst the diplomatists at home fought wordy battles with equal vigour. On the whole, the Dutch, who generally worked fairly harmoniously with the Danes, seem to have had the best of it, and in 1623 they began to erect permanent settlements on the shore for rendering down the blubber, which eventually expanded to a considerable settlement known as Smeerenburg, of the "rise and fall" of which Sir Martin Conway has given such an interesting account in a privately printed pamphlet (undated); they also had depôts in the island of Jan Mayen. For having roughly driven two Biscayan vessels from their fishing grounds, only to subject them to similar treatment from the English, the Frenchmen took a speedy revenge. Staying behind until the Dutch had returned home, they pillaged the Jan Mayen station, loading up with the spoil, which they sold in France, and destroying what they could not remove. After the sack of St. Jean de Luz by the Spaniards in the winter of 1636, when the French whaling fleet was practically destroyed, very little is heard of the Biscayans, and they finally ceased to send out vessels in 1639. In 1642 the much persecuted whales began to abandon the bays where once they had been so plentiful, and the vessels had to follow them into the ice. This led to their adopting the plan of trying out the blubber at sea or carrying it home to extract the oil, thus rendering the shore stations useless, and they were gradually abandoned, till, by 1653, Sir Martin Conway tells us, the once famous summer settlement of Smeerenburg was finally abandoned.

It need hardly be said that the animal which formed the quest of these ancient mariners was the Polar Right Whale, which yields the valuable "whalebone" as well as oil, and that the Sperm Whale, a toothed whale inhabiting the southern seas, was quite unknown to them, or, at most, only occurred as an accidental wanderer in the Arctic seas.

The Right Whale has of late years been practically exterminated in the East Greenland seas, and those now fished for from Shetland, Iceland, and Spitzbergen are various species of "Finners," which occur in considerable numbers and yield a varying quantity of oil according to the species, but far less than the Polar whale; their whalebone is also short and brittle, and of little value. When these whales are killed they rapidly sink, and are difficult to recover; therefore, it has become the practice to pump air into the abdominal cavity to cause them to float, but I never heard of "gas" being injected for that purpose as stated by the magazine writer referred to, and if he is not mistaken it is quite a new departure. Decomposition sets in very rapidly in a dead whale, and the appearance which the author of the paper very excusably mistook for the extrusion of the tongue is a prolapse of the lining membrane of the throat caused by the pressure of the air in the abdominal cavity; this is seen in the case of stranded whales which have been some time dead, and would doubtless be more pronounced after artificial inflation.

The extent to which these Fin Whales have been persecuted since Herr Foyn's invention in the waters of both Europe and America has already greatly reduced their numbers, and it needs no great gift of prophecy to predict their early extermination; they are slow of reproduction, and long in coming to maturity, and the only hope is that when they become too scarce to render their pursuit profitable a remnant may be left to insure the continuance of the race.

I hope it will not be thought that in penning the above remarks I am merely indulging in carping criticism. My object is to call attention to the want of even rudimentary knowledge of these interesting animals on the part of the general public, notwithstanding the many excellent recent works on Natural History to be found in all our free libraries. It might possibly be excused that the uninitiated should fail to distinguish between the Right Whale of the North Atlantic and its relative inhabiting only the Polar Seas; but that the latter should be confounded with the Sperm Whale—so totally different an animal—whose proper home is in the Southern Oceans, is simply incredible.

It is not easy to make the personal acquaintance of these giant animals, but a visit to the whale-room at South Kensington Museum ought to convey much general information, and I can promise those who pursue the study that they will find it a very fascinating one.

ROYAL INSTITUTION.—The following are the Lecture Arrangements at the Royal Institution, after Easter:—Professor G. Baldwin Brown, Two Lectures on Greek Classical Dress in Life and in Art; Professor William Stirling, Three Lectures on Glands and their Products; Dr. P. Chalmers Mitchell, Two Lectures on The Digestive Tract in Birds and Mammals; Rev. J. P. Mahaffy, Two Lectures on (i) The Expansion of Old Greek Literature by Recent Discoveries; (ii) The Influence of Ptolemaic Egypt on Græco-Roman Civilisation; Professor William J. Sollas, Three Lectures on Man and the Glacial Period; Professor Charles Waldstein, Three Lectures on English Furniture in the Eighteenth Century; Professor Sir James Dewar, Two Lectures on The Old and the New Chemistry; and Professor W. Macneile Dixon, Two Lectures on (i) The Origins of Poetry; (ii) Inspiration in Poetry. The Friday Evening Meetings will be resumed on April 27, when Professor John W. Gregory will deliver a Discourse on Ore Deposits and their Distribution in Depth. Succeeding Discourses will probably be given by The Hon. Charles A. Parsons, Professor J. H. Poynting, Professor Arthur Schuster, Mr. Leonard Hill, Professor H. Moissan, and Professor Sir James Dewar, and other gentlemen.

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Irritability.

Reaction of Protoplasm to Stimuli.

By HAROLD A. HAIG, M.B.

PROTOPLASM will react to external stimuli and within limits can adapt itself to stimuli of an unusual and powerful nature. But if these latter be too long sustained a complete or partial cessation of function will result.

Let us take the case of a turgescent root-hair surrounded with a dilute aqueous solution of various salts. Some of these salts will be selected to the exclusion of others, the protoplasm lining the cell-wall, or, rather, the layer known as the ectoplasm, showing what is known as a selective capacity for certain salts. Now this process shows us that the ectoplasm by reason of its reaction to the stimuli of some salts and not those of others acts as a kind of sieve, and keeps up the requisite osmotic equilibrium. A non-living membrane shows no such predilection for some salts over others; in fact, there must exist in our layer of protoplasm the capacity of reacting specifically to some kinds of chemical stimuli over and above others.

Take again the case of naked masses of protoplasm (plasmodia) when subjected to the influence of some irritant: retraction will in some cases occur, in others attraction, and here again we find the same kind of specific irritability. These phenomena are not to be explained on purely physical or chemical lines, but are of a complex nature in which both physical and chemical changes occur. Later on we shall see that rapid changes in metabolism have probably a large share in the production of the various external manifestations such as alterations in shape of the protoplasm, movements, and so on; but some of the intrinsic molecular changes which take place when a stimulus is applied to protoplasm are so hidden that as yet no satisfactory theory has been advanced to explain all the changes which take place between a stimulus and its effects.

In the animal cell we find conditions are somewhat different; in the first place we cannot make any distinction between an outer transparent and an inner granular layer of protoplasm, such as is possible in plant cells, and, moreover, no true cell-wall exists. Under the influence of certain irritants, as, for instance, the mineral acids, we find that living cells from a given part of the body, such as the skin, will, some of them, become completely disorganised, and adjacent cells show signs of increased rapidity of division, a fact pointing to a reparative process, and due to the stimuli transmitted by neighbouring injured cells. Instances of this reparative process occur at times in plants, as in the case of the production of a cushion of callus round the edges of a cut made through the bark of a tree so as to include the cambium and xylem; and in the overgrowth which occurs in certain cases where a parasite attacks a plant.

In those cases where animal cells are exposed to the action of the bacterial toxins, a very complex result often ensues; in some cases, as is well known, the cell will resist the poison, and produce substances known as antitoxins, which tend to arrest or neutralise the action of the bacterial toxin. In other cases toxic bodies are formed outside the bacterial cells from substances either in the animal cell or from the media surrounding them (extracellular toxins), and these, by their irritant action, either kill the cells or stimulate them to form antitoxins.

When a cell becomes incapable of reacting to the irritant, it undergoes a process of degeneration (fatty degeneration), which ends in complete disorganisation and breaking up of the protoplasm into droplets of fatty material. Often certain cells take on a reparative or protective function, and form a layer round colonies of bacteria, enclosing them and finally indirectly affecting their destruction (as in an abscess).

We see, then, that in both the plant and animal cell a definite reaction takes place whenever the cell is exposed to an irritant; in the plant cell there is in most cases either immediate cessation of function, where the irritant is powerful enough, or the occurrence of a physical or chemico-physical process, which tends to remove the protoplasm away from the source of irritation when harmful, and place it in a kind of defensive equilibrium. In the animal cell, on the other hand, the first indication of reaction is one of increased cell-division (where vascular tissues are concerned there is also an emigration of certain cells, leucocytes, which act partly as phagocytes and aim at destroying the irritant), followed in some cases by the formation of a layer of cells, which enclose the irritant and proceed with repair. Now, it may be asked, why should protoplasm react in this manner to stimuli? The retraction of plasmodia away from an irritating substance, and the increased rate of cell-division in the animal cell when stimulated cannot be due to purely physical or chemical causes acting separately. When we say that "irritability" in a plant or animal cell is that property which enables it to react to a stimulus of whatever nature, we merely state the bare fact that by reason of it certain changes occur which somehow alter the previous relations of the protoplasm, but we offer no explanation as to why such changes should occur. As a matter of fact, it is probable that intrinsic changes do take place in the ultimate physical constitution of the protoplasm, whereby a rearrangement of molecules takes place without altering the general chemical constitution. The change, in fact, must be very similar to what takes place when a nerve transmits a stimulus from its peripheral to its central end or *vice versâ;* in this latter process it is known that electrical changes take place, a fact which points to the occurrence of rapidly alternating anabolic and katabolic changes, these manifesting themselves in a current which travels in a certain definite direction.

Recently it has also been shown that any living protoplasm will manifest electrical changes when irritated, pointing to the same anabolic and katabolic changes, and the quiescent protoplasm of seeds which have lain dormant for years will, when an inciting current is passed through them, show what has been called a "blaze-reaction," that is, an electrical response-current, which indicates that the protoplasm is irritable and has reacted. (See Dr. Waller's Experiments with Seeds.)

Experiments such as these have enabled us to gain some little insight into the complex processes involved in the reaction of protoplasm to irritation, but still they do not show us how it is that increased anabolic and katabolic processes are set going subsequent to irritation. That metabolism produces electrical changes is well known, and such changes are, of course, the sequel of any chemical and many physical processes; living

protoplasm must be looked upon as being a substance of extremely unstable constitution, such, indeed, that the slightest stimulus will cause an immediate katabolic followed by a rapid anabolic change, both of these being an increase of the usual metabolic changes. This change is capable of being transmitted from cell to cell by means of the protoplasmic connecting strands, and it is thus that we are able even in plants to explain the transmission of stimuli from one part to another of the same organism.

The anabolic change is to be looked upon as a process tending towards repair, but the protoplasm remains in the same unstable equilibrium as before.

Protoplasm that has been killed has passed into a state of stable chemical and physical constitution, and has undergone a complete change with regard to the arrangement of its individual molecules; in fact, it is the very instability of living protoplasm that endows it with its peculiar property of responding at once to stimuli. Protoplasm once dead is open to the ordinary processes of chemical decomposition, but on account of the stable arrangement of its molecules is no longer capable of responding to external stimuli. One of the most important conditions for the retention of irritability is the presence of oxygen, whereby metabolic changes can proceed; and the presence of water both in combination with the protoplasm and otherwise is essential, all living protoplasm having some "water of constitution" which is present in the protoplasm of the driest seeds. Naturally, in living protoplasm, anabolic and katabolic changes are always proceeding to a certain extent, and when above we mentioned the rapid succession of these processes as being one of the essential concomitants in the reaction of protoplasm to stimuli, it was meant that these processes occur then with greater intensity and in regular alternation. A "Current of Rest" is always present in living protoplasm, but when a stimulus is given to it, anabolism and katabolism proceed with a fixed period of alternation, and with greater intensity than before, giving rise to an increased current or "current of action"—very similar to what happens when a muscle passes from a state of rest into one of contraction.

In fact, a close analogy might be drawn between a muscle and a cell; a muscle responds to a stimulus by contracting, and during this contraction certain electrical changes take place, metabolism is increased, and heat is produced; the protoplasm of a cell responds to stimuli by, perhaps, some alteration in shape, or in some cases by more rapid movement round a cell cavity, and during this metabolism is increased and electrical changes take place. But in both cases it is probably the more rapid succession of the metabolic changes, consequent on the stimulus, that is the cause of the outward manifestation; as to the alteration in the physical arrangement of the molecules, this is as yet undetermined, but, with the increase in scientific knowledge, will no doubt be explained at a later date.

RARE ELEMENTS.—A revised table has been compiled by Mr. E. L. N. Armbrecht, and is published by Messrs. Armbrecht, Nelson & Co., of the Rare Elements. The table, which is of considerable interest as well as of great utility, gives the symbol, specific gravity, atom's weight, principal source, and chief properties of each of some seventy of the rare elements. The name of the discoverer and in some cases the name of the chemist who first isolated the metal or element is also added; and, by no means least in importance or interest, the market price of the element is furnished. From this it appears that, subject to the natural fluctuations, Yttrium, Vanadium, Thorium, Tantalium, Ruthenium, Rubidium, Rhodium, Niobium, Lanthanum, Iridium, Indium, Erbium, Beryllium and Barium are the chief of the rare elements which are worth upwards of a shilling a grain.

The Chemistry of Proteids.

By IDA SMEDLEY, D.Sc.

OF the three great classes of substances which form the chief products of animal metabolism—fats, carbohydrates and proteids—the last-named have for long withstood all efforts to determine the nature of their constitution. Although this problem has occupied the attention of more workers than almost any other group of substances, it is only within the last five years, chiefly owing to the brilliant work of Emil Fischer and his pupils, that we are in a position to form some definite conception of the nature of their atomic structure. The steps made in this direction have so far only led us to the synthesis of peptides, substances of much smaller molecular size than the native proteids, bearing, however, considerable resemblance to them, and occurring among their cleavage products. Such syntheses may probably be regarded as analogous to those of the simple hexose sugars, the structure of starch and of the more complex carbohydrate molecules remaining unsolved.

The earlier investigators were very largely concerned with the isolation and classification of individual proteids; the latter based mainly on differences in two physical properties, temperature of coagulation and solubility in the presence of inorganic salts. Unfortunately in dealing with these colloidal substances, the identification of chemical individuals presents great difficulties, the properties relied on in classification being those which would be readily affected by the presence of impurities. It has recently been shown that members of two of the most sharply differentiated of these classes, the albumins and globulins, under certain conditions suffer mutual conversion. A more satisfactory scheme of classification will probably be based on differences in their chemical structure, but for this, a knowledge of their decomposition products and the proportions in which they are present, more complete than we at present possess, will be necessary.

The colour reactions given by the proteids when treated with various reagents were also investigated, and some attempt made to allocate the groups in the molecule characteristic of special reactions; in this field our knowledge, though recently considerably extended, is still far from complete.

A study of the gradual decomposition of proteids by hydrolysing agents, both acids and enzymes, resulted in the separation and classification of the non-crystalline derivatives of digestion, albumoses, and peptones, and also in the isolation of a number of crystalline amino-acids, the best characterised being leucin and tyrosin. In the recent extension of our knowledge of these simpler decomposition products, the work of Kossel and of Emil Fischer stands pre-eminent; the former isolated his so-called "hexone bases" arginine, lysine, and histidine, the constitution of all of which has now been definitely established. To Emil Fischer we are indebted both for the isolation of new compounds and for definitely establishing the constitution of products which former investigators had only succeeded in separating. The problem of the structure of proteids may be attacked both by analytical and synthetical methods, the latter being dependent on the former, since the simple decomposition products isolated will afford a clue as to the materials to be employed in synthesis. Now, although

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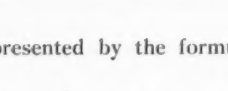
the number of these ultimate products identified has been recently much increased, the substances isolated all belong to the class of amino-acids; that is, they contain the characteristic acid carboxyl group "COOH" and the amino group "NH_2," or a derivative of this. It has, however, been shown that in addition to the mono- and di-amino acids, examples of which were already known, a new class of amino-acids in which the nitrogen is bound up in a ring, is present; as instances of these cyclic nitrogen-containing acids and pyrrolidine carboxylic acid, isolated by Fischer and represented by the formula



may be cited, and histidine and tryptophane are other members of this class.

The presence of oxy-amino acids among these cleavage products is of interest since these may form a link between carbohydrate and proteid in the animal organism.

In all, the identity of about twenty of these products is now established, but the number of these obtained from any one proteid varies considerably; from the decomposition of casein, the chief proteid present in milk, as many as sixteen of these acids have been isolated, whilst the comparatively simple protamines obtained by Kossel from the sperm of fishes give only three or four of them.

These amino-acids form, therefore, the starting point of all attempts at synthesis. In order that the synthesis may be successful, two conditions are requisite; in the first place, the synthetic substance must possess the properties characteristic of the proteids; it should give certain colour-reactions, notably a pink or violet colour, when solutions of copper sulphate and caustic soda are added and known as the "biuret" test; it should be similar in physical properties, and it should be broken down both by mineral acids and by the proteolytic enzymes giving simple amino-acids. The second condition is that the method of synthesis should lead to a product the constitution of which may be easily elucidated. Neither of these requirements was fulfilled by the earlier attempts at synthesis; it is true that Curtius as early as 1882 isolated his "biuret base" as the result of the spontaneous decomposition of ethyl glycine, but its constitution was only determined two years ago by its discoverer after it had been shown by Schwarzschild to be decomposable by the pancreatic enzyme, trypsin. The only systematic attempts at synthesis are those of Emil Fischer, who has succeeded in finding a general method by which long chains of amino-acids may be built up into complicated molecules of undoubted chemical individuality and of determinate structure. The method appears capable of wide application, and consists essentially in treating the chloride of a halogen-substituted amino-acid with an amino-acid ester. The resulting ester is saponified, and the halogen atom subsequently removed by treatment with strong aqueous ammonia.

This is represented by the following equations:—

$$CH_2Cl.COCl + NH_2.CH_2CONH.CH_2COOEt$$
$$\longrightarrow CH_2ClCONH.CH_2.CONH.CH_2COOEt$$
$$\longrightarrow CH_2ClCONH.CH_2CO.NHCH_2COOH$$
$$\longrightarrow CH_2NH_2.CONH.CH_2CONHCH_2COOH$$

These condensed amino-acids are termed by their discoverer "peptides," the number of amino-acids coupled up being signified by the prefix di, tri, tetra, &c. Many of the decomposition products of native proteids have been used as the building-stones in this method; glycocoll, alanin, leucin, tyrosin, and several others have been made to react with the chlorides of halogen derivatives of different fatty acids, and a great variety of products have thus been obtained, as many as five acids having been built up into one large molecule. The properties of these polypeptides vary with the radicals employed; they show less disposition to crystallise as the number of residues built up increases; they are soluble in water, those produced from optically active acids being most soluble; they are precipitated by the re-agents used to precipitate proteids, many give the biuret reaction, and if tyrosin be one of the acids used in their synthesis Millon's reaction is also given. In addition, those built up from tyrosin and leucin are acted upon by trypsin, these acids being split off as in the action of enzymes on proteids. The peptides show, therefore, properties closely analogous to those of the proteids, and the manner in which they are built up furnishes us with valuable evidence as to the probable atomic structure of the proteids themselves.

Substances similar to these synthetic polypeptides have now been isolated by Fischer from the products of hydrolytic decomposition of proteids, and this furnishes strong evidence that the method of combination in these compounds is closely allied to that in the proteids themselves. The hydrolysis by enzymes or acids consists essentially in the addition of the elements of water and in the subsequent splitting up of the proteid molecule. This decomposition is gradual, and takes place in successive stages, smaller and smaller molecules being split off. Various investigators have brought forward different schemes by which this action may be represented; most of these are open to dispute, for much remains to be known as to the exact relationships obtaining between these products. The proteid goes into solution in the presence of alkali or acid in the form of alkali or acid-albumen; this is followed by the appearance of albumoses, and at a later stage peptones are detected, all which substances give the biuret test. Much discussion has raged round the number and nature of the albumoses and peptones formed. By some investigators they are classified into two groups, one of which is completely resistant to the further action of enzymes, and remains, therefore, as an end product of enzyme digestion; the second group, on the other hand, is readily attacked by these agents. It has for long been known that proteids are much more readily and completely broken down by the action of acids than they are by the action of enzymes. It has now been shown that although the action of the latter is very much slower, it may be nearly as complete as that of acids. Fischer and Abderhalden carried out a series of experiments in which proteids were digested with pancreatic ferment for as long as seven months; at the end of this period hardly any trace of the biuret reaction was observable in the solution. Since the biuret test is characteristic of both albumoses and peptones, it follows that both these substances had disappeared, and can no longer be regarded as end-products of the action of enzymes, their power of resistance being only one of degree. The solution thus obtained by prolonged pancreatic digestion contained not only the acids already identified, but, in addition, a complicated polypeptide, giving a barely perceptible biuret reaction, and decomposed by further hydrolysis with acids into six already isolated amino-acids.

Other observers, notably, Zunz and Pfaundler, had already pointed out that if one endeavours to trace quantitatively the course of proteid decomposition by

estimating the amount of nitrogen in the various products separated at the different stages, there is from the very earliest period a considerable discrepancy when this is compared with the amount of nitrogen in the original proteid.

This must mean that substances are formed which are not detected and isolated by the methods made use of for this purpose, and that a large proportion of soluble nitrogenous products, not giving the biuret reaction, are formed. Pfaundler succeeded in showing that these products, if submitted to the action of acid, gave rise to amino-acids, which could then be detected in the solution. These products are, then, similar to the polypeptide now isolated.

Another point that has been clearly established is that these amino-acids vary greatly in the ease with which they are split off. Leucin and tyrosin are the two first amino-acids to appear and separate at a comparatively early stage of digestion. It is true that these acids are more easily detected than many of the others, but careful search has failed to detect the presence of other acids at an equally early stage, and in this connection it is interesting to note that the synthetic peptides built up from these acids are the ones which were found to be attacked by enzymes.

These soluble polypeptides possibly form a kind of resistant nucleus in the proteid molecule. The view that a resistant nucleus remains after various simpler groups have been split off has long been held; its nature has been much debated, and is still unsettled, though the theory that it is a polypeptide-like body finds considerable support.

We may regard the proteid molecule as built up, therefore, of a large number of amino-acids, the structure of which suffers very little change in this incorporation, so that these acids are again readily split off. The nature of this linking is probably that indicated by Emil Fischer and described above. Certain of these groups appear to offer a more vulnerable point of attack on which the hydrolysing agent seizes to begin the demolition of the molecule. This demolition only can proceed gradually, resistance being offered at every stage.

The great problem of the method of absorption of proteids from the alimentary canal, of which so little is known and which is yet of such vital importance, is intimately bound up with the question of proteid chemistry. We can trace the digestion of the proteid in the alimentary canal and detect there albumose and peptone, but in the blood vessel which carries away the products of digestion neither albumose nor peptone can with certainty be detected, and we can detect no increase in its proteids as the blood leaves the alimentary canal after a meal. The detection of small quantities of albumose and peptone in the blood would not be easy, and a slight increase of proteid might readily escape observation, for the estimation in such a dilute solution does not permit of extreme accuracy. On the other hand since the breaking down of the proteid is more complete than was at one time supposed, the nitrogenous matter may be absorbed in the form of some of these simpler soluble substances, which have for so long remained undetected; indeed, it is found that peptides and amino-acids administered as food, lead to an increased excretion of urea.

Certain feeding experiments have been carried out with the object of throwing light on this most difficult and most fundamental of problems. Löwi showed that nitrogenous equilibrium may be maintained in dogs fed with the crystalline cleavage products resulting from the pancreatic digestion of proteids, which no longer give the biuret reaction. The experiments of Abderhalden do not fully support this; he found that casein and the products of pancreatic proteolysis of casein were equally efficacious as foods; this solution, however, still gave a biuret reaction, and if the digestion were carried further by treating the proteid with acid, death resulted if the feeding was continued for long with such a solution. Further development of such work is desirable, for it would be of the very greatest importance if it could be established that the complicated proteid is not an essential food for the maintenance of animal life.

Now that the synthesis of the simpler carbohydrates is an accomplished fact and that of the simpler proteids has been brought within the region of probability, the old distinction at one time drawn between plant and animal foods loses much of its force. Plants we know can from the simplest materials, carbonic acid and water, manufacture carbohydrate, whilst their nitrogenous food may be supplied to them in the simple form of nitrate or ammonium salt. Animals, on the other hand, require carbohydrate and proteid to be supplied ready-made, some living organism having already accomplished the work of elaboration. It is not so very long since these substances seemed almost removed from the possibility of synthesis; it was as if they were divided off by barriers, akin to those that were supposed to separate organic and inorganic substances before the first organic compound had been synthesised in Wöhler's laboratory. If now it can be shown that it is merely a question of the form in which the simple food is supplied, and that an assortment of these comparatively simple amino-acids will serve as nitrogenous food, the difference between the complexity of plant and animal food becomes of a much lower degree, and the idea of a synthetic laboratory food no longer is to be regarded as an impossibility.

The Work of Radium.

WHAT is the work that is being done by radium as it continues—for 30,000 years or more—to shoot out atoms and electrons? Some attempt to give a concrete illustration of its accomplishment has been made by M. Holzmuller, in continuation of the calculations made by Dr. Wien. A milligramme of radium shoots out some 29,000,000 negative electrons every second with a speed approximately five-sixths that of light. These are the β rays. It is also sending out α rays which are particles much more massive, but the speed of which is only one-eighteenth that of light. The amount of work which is thus being done can, of course, only be expressed in "ergs." M. Holzmüller's calculations take as their starting point that a milligramme of radium bromide is doing work equal to 72·2 ergs a second. But the pure radium in radium bromide is only three-fifths of the whole substance, so that the radium is actually doing more work than this; and to cut these calculations down to their smallest possible proportions we arrive ultimately at the estimate that a milligramme of radium before it has exhausted all the energy occluded in its atoms will have done some ten billion ergs of work. In other words, it will have done work equal to 100,000 kilogrammètres; and, to make the final mathematical reduction, a gramme of radium, which is a very small crumb of material, exhausts in the course of its life an energy equal to work at the rate of one horse-power for 15 days.

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Photography.

Pure and Applied.

By Chapman Jones, F.I.C., F.C.S., &c.

The Developable Image.—During the last few months there has been a good deal published about the developable image. The speculations as to the character of the change wrought in the silver salt when it is converted from the non-developable to the developable modification may, as always before, be divided into two classes, namely: (1) those in which decomposition of the silver salt is assumed, and (2) those in which it is taken for granted that the salt is not decomposed. Some of the more recent ideas can claim no other novelty than that they are expressed in more modern terms, for with so simple a substance as silver bromide there is not very much scope for ingenuity in devising suggestions as to its possible changes. When a chemical change, that is, decomposition, is assumed, it is considered that there may be formed a solid solution of a silver bromide that contains less bromine than AgBr, or, perhaps, of metallic silver, in the unchanged bromide. Assuming that there is no decomposition of the molecule, it is suggested that the change may be due to the loss of an electron.

The one certainty that underlies all these speculations is that there is a change. I think that we may go a step further and state that the change is of a physical kind, because I believe that it is impossible to conceive of a change that is not physical. But as to whether the change goes a stage further and actual decomposition results, or if the change is physical only, the nature of it, are problems that appear to be but little affected by recent publications. It is easy to say that certain theories are in accord with certain experimental results, but the difficulty is to find a theory that will fit all the facts. A catalogue of the known properties of developable silver bromide would be of much more use than a great many of the suggestions as to its constitution, and the list would certainly show that several of these suggestions cannot be true. If such a catalogue were made, some idea of the character of the evidence upon which each of the supposed properties rests should be given, for some investigators have a most unfortunate way of mixing up their theoretical ideas with their experimental results.

Precision in Photography.—I suppose that there is no other art that is practised in so happy-go-lucky a way as photography, even when taken up by those who have been trained in accurate manipulation. The precision wanted is not in compounding developers to within a unit or two per cent., nor in timing development to a second, this would be foolishness and not exactness, but it is surprising, for example, how rare is the ability to focus critically. In the majority of cases it is not due to defective vision, but merely to a careless want of appreciation of what critical focussing is. Perhaps the inherent inexactness of work done by holding a camera in the hand has something to do with it, but the chief reason appears to be that the attitude of even scientific persons towards photography is often strictly comparable to that of the very ignorant with regard to microscopy, whose notion is that anyone can look at an object through a microscope and see an enlarged representation of it. We have improved a little in this during the last few years, but not very much. The successful practice of any art requires a sympathetic appreciation of its possibilities, and a clear understanding of the requirements of each particular application of it.

Uranium Toned Prints.—Uranium toned bromide prints are notoriously so unstable that those who desire the warm colour they show would do well to try toning with copper ferricyanide instead. It is curious that a uranium intensified negative has the reputation of stability, and appears to deserve it, though there is no sufficient reason to doubt that the change is the same in both cases. M. L. Lemaire states that he has traced the liability to change in prints, to the presence of silver ferrocyanide, and says that if this is removed they become stable. He proposes to remove it with potassium thiocyanate, or by treating the prints with a weak alkali followed by dilute nitric acid. This last method must present difficulties, as alkaline solutions will remove the uranium compound. Although the fact is undisputed that uranium toned prints are very liable to fade, the reason is still not clear. Indeed, the exact change that takes place during toning and the composition of the resulting image do not appear to have been determined.

Received.—Messrs. Ross, Ltd., send their catalogue for 1906, which includes their well-known lenses, several between-lens shutters, including a new one, the "Koilos," and cameras, &c.

Mr. Butler, of 20, Crosby Road, Birkdale, Southport, sends a new illustrated pamphlet of his patent "swincam" camera stand.

"What can be done with a Goerz lens?" is an excellently illustrated pamphlet, from C. P. Goerz, 1, Holborn Circus, that describes the various uses and capabilities of the several kinds of photographic objectives made by this firm.

A copy of either of the above will be sent on application to the firm concerned.

Correspondence.—H. E. McColl.—The process of chlorinating the developed but unfixed plate, dissolving out the silver chloride with ammonia and then reducing the silver bromide, does give a fogged image for the very reason you suggest. Probably the seeming discrepancy between the amount of bromide left in the high lights and the fogging is apparent only, it is difficult to judge by the mere appearance. You might try the effect of omitting the ammonia and communicate the result if of interest. It is not possible to say anything about your second experiment as the composition of the film you started with is not known except to the makers. The conversion of P.O.P. into a development paper is not new.

Papers Read.

At the meeting of the Zoological Society held on March 6, Mr. R. Shelford read a note on flying snakes alluded to elsewhere; the other communications at the same meeting consisted of reports on the organisms obtained from Lake Tanganyika and other Central African lakes during a recent expedition. Of these, Mr. Boulenger took charge of the fishes, Dr. Calman reported on the crustaceans, Mr. Edgar Smith discussed the mollusks, and Mr. Kirkpatrick described and recorded the sponges. At the meeting of the same Society held on March 20, Mr. Thomas described a new form of brown bear from the Shan States of Upper Burma, which is of special interest from the fact that bears of this group have hitherto been quite unknown from this district. Mr. G. A. K. Marshall, on the same occasion described no less than 22 species of beetles belonging to the genus *Sciobius*; while Dr. Gadow discussed the evolution of the colour-pattern and the arrangement of the scales in the Mexican lizards of the genus *Cnemidophorus*. At the meeting of the Geological Society on March 29, Mr. S. S. Buckman discussed "homœmorphy" in brachiopods.

NOTES.

ASTRONOMICAL.

By CHARLES P. BUTLER, A.R.C.Sc. (Lond.), F.R.P.S.

Temperature of the Sun.

M. MOISSAN has recently published another section of the results of his investigations on the distillation of various substances in the electric furnace, and that in relation to titanium is specially important for solar physics by reason of the widespread occurrence of that element in the solar spectrum, occurring as it does in both chromosphere and sun spots. Unlike boron and carbon, which appear to distil directly into vapour from the solid state, titanium was found to assume the liquid intermediate state, and by careful measurements with specially constructed thermometers it is possible to gain an approximate estimate of the temperature of volatilization. Using a current of 1000 ampères at 55 volts, he found that, starting with 300 grammes of material, after seven minutes about 110 grammes had been distilled. Various measures of the arc temperature have been made, the best of which is probably that of Violle, who estimates the maximum temperature to be about 3500° C. In transferring this to estimates of the solar temperature, however, the fact must be remembered that the pressure at the sun's surface may be vastly different to our terrestrial atmospheric pressure, and thus the temperature at which a certain metal can exist as vapour may also be greatly modified.

Terrestrial Shadow Bands.

An interesting account of the observation of terrestrial shadow bands is communicated to the Bulletin of the French Astronomical Society by M. A. Chevremont, who was particularly struck with their similiarity to the moving shadows seen just before and after the total phase of solar eclipses.

The observations were made in Quiberon Bay, during the stay of the North Squadron. During the night exercises the powerful searchlights from the warships repeatedly rested on the white vertical walls of the buildings on shore. The dark bands, very clear, with an undulating motion, were from 10-15 cm. wide, and had a motion of 4-5 metres per second. The wall forming the screen was oriented to the East, and was placed perpendicularly to the rays from the projectors, of which the distance was about 3½ kilometres. Under those conditions the bands were displaced from the North to the South. They were best seen at about 10 metres distance. Similar fringes were seen on another wall oriented North-east to South-west, thus being very oblique to the line of rays, and in this case, as before, the shadows moved from right to left.

Relation of Solar Prominences to Magnetic Storms.

Very definite coincidences were observed on several occasions during 1905 between the outburst of special prominences and movements of the magnetic needle.

On January 29, 1905, a very remarkable eruption was observed which appeared to proceed from the centre of the great spot group, then near the east limb, but it was very notable that no metallic reversals were visible. In the same spot region, however, strongly metallic eruptions were detected by Professor A. Fowler on February 2, 1905. Later in the year, on November 10, 1905, Mr. J. Evershed observed another metallic eruption at $9^h\ 15^m$ to $9^h\ 35^m$ a.m., during which the sodium, magnesium, and enhanced iron lines were brilliantly reversed for some time. It is very important to note that the magnetograph records at both Greenwich and Stonyhurst Observatories show very minute disturbances on February 2 and November 10, exactly at the times of active phase of these two metallic eruptions.

New Catalogue of Bright Stars.

A most useful catalogue of the brighter stars has recently been published by M. J. Bossert, one of the astronomers at the Paris Observatory. The best positions have been adopted for stars in both hemispheres, and brought up to the epoch 1900°. The list contains the co-ordinates of 3800 stars, giving the right ascension and north polar distance; the limit of magnitude is 7·0. A rather peculiar but useful arrangement is that the stars are grouped in zones of 1° of polar distance, and then ranged in each group by their right ascensions, instead of the more common one of order of right ascension throughout. A very complete introduction gives all the necessary details and formulæ for computing the star places at other epochs.

BOTANICAL.

By G. MASSEE.

Desert Vegetation.

IT has long been known that the plants of desert regions possess marked peculiarities, both morphological and physiological, which enables them to retain a foothold under such exceptional surroundings. With the object of investigating these matters under the most favourable conditions the Americans have established a Desert Botanical Laboratory at Tucson, Arizona.

The water relations of the plants of arid regions are so very delicately adjusted that a very slight variation in the available supply, or in the relative humidity of the air, produces a very quick and notable effect. A shrub called Ocotillo (*Fouquieria splendens*) responds quickly to an increase in the water supply. Owing to a long period of drought, a specimen of this plant had, up to June 29, been for several weeks without leaves. On June 29 three gallons of water were poured slowly on the ground at the base of the plant; on July 1 leaf-buds were observed, which at 2 p.m. on the following day had become 1 cm. long, and four days afterwards the leaves were full grown. Other plants of Ocotillo showed the same response to an increase in the water supply.

Palo verde is so called because not only are the leaves green as in other trees, but mainly on account of the green colour of its twigs, branches and stem, all of which are probably capable of giving off water vapour from their surface, and also capable of assimilating carbon dioxide. Palo verde has a low rate of transpiration, and the possible range of transpiration is also small as compared with other desert forms; that is, the maximum rate in summer, when the leaves are on, is not much greater than the minimum, when the leaves have fallen, as is the case with other desert plants that have been studied. In cases of extreme drought the leaves are shed, consequently the area of transpiration is reduced and the necessary adjustment of the rate of transpiration is accomplished.

The period of activity of plants depends on the period during which they retain their leaves. In the case of desert plants growing under adverse conditions, in addition to the large amount of moisture present in the air—which retards transpiration and thus assists the plant in reserving to some extent the amount of water at its disposal—it is considered probable that the leaves absorb atmospheric moisture in sufficient quantity to be of biological importance.

It has been proved that stems of Ocotillo absorb both water and atmospheric moisture; it has also been shown that a branch of Ocotillo without leaves can absorb a sufficient amount of water to induce the formation of leaves.

Plant Life in Spitzbergen.

Dr. Wulff, who accompanied a Scientific Mission to Spitzbergen, paid special attention to the ecological condition of the flora. Transpiration was found to be very feeble and without marked diurnal periodicity. This imperfect transpiration is considered as one of the causes of the feeble growth of Arctic vegetation. Anthocyanin is present in about half the number of the higher plants. It is always absent from plants growing on soil mixed with the dung of wild birds, whereas it is present in the same kind of plants when growing in impoverished soil.

Anthocyanin is considered as an absorber of energy, and without it no plant can become dominant in Arctic regions.

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Fossil Conifers.

Some interesting discoveries of fossil plants from the Portland beds of Boulogne have been described by Flicke and Zeiller. One is a cone of *Sequoia* of the *S. gigantea* type, which is named *S. portlandica*. Previous to this discovery the oldest known cone was *S. lusitanica*, from the Wealden beds of Portugal, which belongs to the living *S. sempervirens* type. We have now evidence of the existence of the two living types of *Sequoia* as remote as the Jurassic period, hence the origin of this genus must be very remote.

Pine cones were also found representing the two leading groups, *Strobus* and *Pinaster*, living at the present day. One cone, named *Pinus sauvagei*, is said to closely resemble small cones of the living *P. laricio*. This discovery in like manner indicates the great antiquity of the genus *Pinus*.

CHEMICAL.

By C. AINSWORTH MITCHELL, B.A. (Oxon.), F.I.C.

Lead Poisoning Through Electrolysis.

A FRESHLY-CUT piece of lead remains untarnished when kept in a closed flask of pure water from which all air has been removed by boiling, but exposed to the simultaneous action of air and water is rapidly corroded, a considerable amount of the metal being dissolved. This action is almost entirely prevented by the presence of the small quantities of salts, notably the carbonates and sulphates commonly present in drinking water, and hence there is usually little risk of lead being dissolved to any dangerous extent by such water. The presence of carbonic acid in the water has a similar protective effect, a thin film of insoluble lead carbonate being formed upon the surface of the metal and protecting it from further action. In the case of soft lake waters the small proportion of vegetable matter generally present plays the same part, forming a compound with part of the lead oxide first produced, which acts like a natural varnish to check the solvent effect of the water. For these reasons lead pipes can be used for conveying the water for household supply, and have usually been regarded as free from danger; but a remarkable case recently recorded by Mr. B. Latham points to a hitherto unexpected possibility of poisoning resulting from the use of lead pipes. The inhabitants of a cottage to which the water was supplied by the South Hants Water-Works were found to be suffering from lead poisoning, and an examination of the supply-pipe showed that corrosion of the metal had taken place. The cause of this was finally traced to a leakage from an electric lighting main close by, and a current with a voltage of 1.8 was detected between the earth return and the lead water pipe. This had caused electrolysis of the metal, which had been brought into solution in sufficient quantity to render the water poisonous. The correctness of this conclusion was established by experiments on a small scale in the laboratory.

Industrial Use of Carbon Tetrachloride.

During the last six months, the use of carbon tetrachloride as a solvent for fats, has become very general in Germany, and it will probably, ere long completely supersede the dangerous carbon bisulphide or petroleum spirit. Carbon tetrachloride is a colourless, mobile liquid, closely resembling chloroform in its general characteristics, though it has no anæsthetic power. It boils at a low temperature, is readily evaporated and condensed, and has the great advantage of being non-inflammable, so that when used for the extraction of fat from bones or other material, the risk of fire is reduced to a minimum. Factories can thus be placed near other buildings, which was out of the question with the highly inflammable solvents hitherto employed, and the fire insurance companies will accept very much smaller premiums. Carbon tetrachloride has a faint characteristic odour. Its vapours are stated to have no injurious effect upon the health of the work-people, and although this point has not yet been definitely determined, they must certainly be much less hurtful than the vapours of carbon bisulphide, which are very poisonous. Special apparatus is required for extracting fat with the new solvent, and this has already been put up in a large number of factories.

The Bacterial Origin of Vegetable Gums.

Three species of bacteria, discovered by Mr. R. Greig-Smith, in the gum and bark of *Acacia binervata*, *A. pinninervis*, and *Sterculia diversifolia*, respectively, produce gum when grown on suitable culture media, such as a solution of fruit sugar (lævulose) with glycerine, and traces of asparagine, tannin, and other substances. Strangely enough, glucose and cane sugar interfere with the production of gum by these bacteria, but on the other hand a new gum-producing bacterium was isolated from the sugar cane, in addition to *B. vascularum*, the cause of the so-called "Gum-disease." Experiments were made in inoculating plants belonging to the *rosaceæ*, with acacia bacteria, and gum was subsequently found to have been produced within the cellular tissue. It is not improbable that this discovery may have a commercial value. In Mr. Smith's opinion, all gums that exude from trees are probably of bacterial origin.

Gioddu: A Fermented Milk.

The inhabitants of the mountainous districts of Sardinia eat large quantities of a fermented milk, resembling koumis or kephir. It is prepared by allowing the milk of the cow, sheep or goat to ferment at a moderately high temperature, either spontaneously or after the addition of baker's yeast, until it thickens into a more or less consistent homogeneous mass, at which stage the fermentation is stopped by plunging the vessel into cold water. The product, which has a sharp acid flavour, is eaten either by itself or is spread as a butter upon bread.

GEOLOGICAL.

By EDWARD A. MARTIN, F.G.S.

Glacial Drift at Moën and Rügen.

THE Rev. Edwin Hill, F.G.S., has laid before the Geological Society the results of his observations on the strange intercalations of drift, which occur in the chalk at the island of Moën. At first sight the drift appears to be interstratified with the chalk, but accepting the theory that the drift was deposited in dislocations in the chalk, it has also generally been assumed that the dislocations were either simultaneous with, or subsequent to, the deposition of the drift. Mr. Hill has, however, examined certain cavities in these dislocations which had been water-worn, and therefore must have been produced before the advent of the drift. It is contended, therefore, that the chalk had been disturbed in pre-glacial times, and the assumption is that there were pre-glacial hills and cliffs similar to the present, with similar clefts and furrows in the cliffs, which were covered in glacial times with a mantle of drift, which is now in course of removal by denudation. This, indeed, seems to be the most natural assumption. Some geologists have endeavoured to show that the intercalations of drift in the chalk both at Moën and Rügen have been caused by the sheer force of an ice-thrust, ramming such deposits into the chalk, but, as Professor Boyd-Dawkins remarked, there was no necessity whatever for invoking this agency, and in view of the water-worn condition shown in some of the dislocations, it would seem that the cavities or fissures were caused by earth-movements, aided by the cave-forming propensities of chalk, some time prior to the formation of the drift.

The Origin of Boulder Clay.

The discussion on Mr. Hill's paper, and another by Professor T. G. Bonney, again brought into sharp contrast the two opposing camps of glacialists, one of which asserts that boulder-clay is undoubtedly the direct product of land-ice, and the other, which asserts with just as little doubt, that this is an impossible solution of the question. Mr. H. B. Woodward and Mr. Lamplugh both professed their unqualified adherence to the land-ice theory, which, as a matter of fact, has found its way into most modern text-books, whilst Professor Bonney and Rev. Edwin Hill

declined to commit themselves to such a view. The former stated that he had asked for years how land-ice could get to England from Scandinavia over the wide and deep channel which contours the latter country, and the best reply he got was that there was a sort of "clearing-house" at the Dogger Bank, or that the channel was post-glacial. He had asked how, if distributed by land-ice, Shap boulders crossed the ice coming from the Cheviots and Scotland, and Arenig boulders crossed those from Criffel and the Lake District, and the only answers ignored the physical properties of ice.

Clay with Flints.

Years ago, the now veteran geologist, Mr. William Whitaker, F.R.S., when engaged on geological survey work in Berkshire, was at a loss to understand the deposit of red clayey material which was constantly met with in chalk districts, and which almost invariably contained a large number of unworn chalk flints. In 1864 he propounded a theory, and held that this clay-with-flints, as he then called it, was a residue from the slow solution of the chalk, although he admitted that it included some material derived from the eocene. Mr. A. J. Jukes-Browne, F.G.S., in conjunction with Mr. William Hill, has now made a careful examination of chalk from various zones, in order to establish whether or no it were possible for the deposit to have been obtained wholly from the chalk, a view which appears now to be very largely accepted, and as, indeed, Charles Darwin appears to have thought. In the result, the experiments which have been made show that 100 cubic feet of the *Micraster-coranguinum*-chalk will produce only 1.2 cubic feet of clay, and the solution of the *Marsupites*- and *Micraster-coranguinum*-zones to the extent of 200 feet over any part of the area would only yield clay enough to make a layer 2 feet deep. Lastly, it is shown that the quantity of flints in the upper chalk is so much greater than the quantity of clay, that the natural residue could not form a clay-with-flints. Thus, solution of 100 feet of *Micraster-coranguinum*-chalk would yield a bed of flints about 7 feet thick, and only enough clay to fill up the interstices between the nodules. The experiments practically show that it is impossible to suppose that the clay-with-flints owes its origin to the small amount of clay contained even in impure chalk. There is a difficulty in thinking, on the other hand, that the pipes in chalk, which are filled by this clay, have been filled simply by the falling of tertiary material into holes of pre-eocene formation. That such holes are still extending is an established fact, and, somehow, they become filled by the clay as they extend. I suggest that they become filled by a process akin to infiltration, which leaves the angular flints practically in the same position which they occupied when surrounded by chalk.

ORNITHOLOGICAL.

By W. P. PYCRAFT, A.L.S., F.Z.S., M.B.O.U., &c.

A Curious Hybrid.

THE interesting collection of hybrids at the Natural History Museum has just been enriched by a life-sized sketch in colours of a very remarkable hybrid bred at Didlington Hall, Norfolk. This sketch, the work of the Hon. Florence Amherst, depicts a male bird, the offspring of a curious blending of breeds, inasmuch as its male parent was a cross between the long-tailed Japanese fowl and a Campiné hen, while its female parent was a common hen pheasant. The general appearance of this extraordinary bird recalls that of the common hen; there are no traces of spurs, and only an indistinct comb, while the tail is short and square. Round the eye is a large vermilion area of bare skin, derived from the pheasant, and similar evidences of pheasant blood appear in the dark blue neck and bright chestnut underparts. Thus this bird exhibits the female characters of its male parent and the male characters of its female parent.

Mediterranean Shearwater in Sussex.

At the last meeting of the British Ornithologists Club an example of the Mediterranean shearwater (*Puffinus kuhli*) was exhibited, which had been picked up dead on Pevensey beach in February last. This makes the first occurrence of this species in Great Britain.

King Eider in Orkney.

Mr. Fred Smalley, in the "Zoologist" for March, records the fact that an adult female king eider (*Somateria spectalilis*) was killed at Græmsay, in February, by Mr. S. Sutherland, of that place.

Pacific Eider in Orkney.

In the *Field*, April 7, Mr. H. W. Robinson records the occurrence of "another so-called Pacific eider (*Somateria v-nigrum*) in Orkney, making the third this winter," and remarks that "all these three drakes with the V-mark on the throat are probably common eiders." The fact that this peculiar mark is by no means rare in the common eider is one of considerable interest, and until recently was never suspected. But the Pacific eider is generally regarded as further differing from the common eider in that the feathers of the lores in the latter extend so far forward on to the beak that the distance between its furthest point and the extremity of the naked angle on the side of the forehead is greater than the distance from the same point and the tip of the beak, while in the Pacific eider the distance from this point to the bare forehead angle is less than that between this point and the tip of the beak.

Arrival of Summer Birds.

The arrival of the following species has already been recorded:—

House martin—Tenby, March 19 (*Field*, March 31).
Sand martin—Wickham, Hants, March 23; Hythe, Kent, March 22.
Willow wren—Eastbourne, March 21; Flax Bourton, Somerset, March 23.
Chiff-chaff—Mitcham, March 17; Bedford, March 18; Salisbury, March 22; Chichester, March 24.
Wheatear—Richmond Park, March 6; Marazion, Cornwall, March 11; Weston-Super-Mare, March 14.
Tree pipit—Ashby Pastures, Leicestershire, March 30.
Redstart—Eastbourne, April 2.
Turtle dove—Aldringham, Suffolk, April 2.

PHYSICAL.

By ALFRED W. PORTER, B.Sc.

On the Effect of High Temperature on Radioactivity.

EXPERIMENTS made by Curie and Danne (Comptes Rendus, 1904) indicated that the rate of decay of radium C can be altered by subjecting it to temperatures above 630° C.

H. L. Bronson more recently made experiments from which he came to the opposite conclusion.

The question is a very interesting and important one, for one of the main characteristics of the emanation itself is its indifference to the circumstances in which it is placed; hot or cold its rate of decay seems to be absolutely unchanged; and indeed this is one of the links in the chain of evidence by which it was concluded by Rutherford that the change that proceeds is not of an ordinary chemical type—for the temperature has a great influence on every chemical reaction—but is ultra-atomic in nature.

In order to obtain further evidence Mr. Walter Makower (Harling Fellow of the University of Manchester) has recently made a series of observations on the influence of temperature upon the rate of decay of the Beta and Gamma activity of an equilibrium mixture of radium emanation with its products radium A, B, and C. The emanation was enclosed in a quartz tube so that none of the products could escape; while the walls of this tube were so thick that the Alpha streams were also stopped; hence any ionisation produced in the air outside must have been due to the Beta particles and Gamma rays. The tube was allowed to ionise the air in a testing cylinder of the usual type, and thus the activity was measured. If sufficient time were given before the tests for the contents of the tube to come into radioactive equili-

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brium, the subsequent decay would follow the exponential law, falling to half value in about 3·7 days. If at intervals the tube is heated to a high temperature and retested when cool, it is found that there is a temporary fall in the activity followed by a gradual recovery. The curve of decay is now not an exponential curve, but consists of such a curve in which a series of notches or depressions are produced; in other words the recovery is such that the same point of the diagram is ultimately returned to as would have been reached if no intermediate heating had taken place. The inference that can logically be made is that some part of the contents of the tube is modified by the high temperature; the results are *consistent* with the explanation offered by Curie and Danne that the rate of decay of radium C is increased by high temperature. In examining this conclusion it is important to recollect that in the disintegration of the emanation and of radium A and B, no Beta particle is emitted; at least none is emitted with sufficient velocity to produce any ionisation; so that the activity measured is chiefly due to radium C. The interpretation then is that the amount of radium C falls off more quickly at the high temperature, so that when the tube is cooled the contents are no longer in radioactive equilibrium; that is to say, radium C is then produced (from B) faster than it decays: hence it increases in amount, and, if time enough be given, the same equilibrium proportion will be reached as if no heating had taken place. This is a possible explanation (and Mr. Makower only claims it as a possible one); it would be well to test it under conditions in which all ambiguity would be removed. Another explanation would be that radium B broke up *less* quickly at the high temperature, for this would diminish the rate of formation of radium C, and cause therefore a temporary diminution of Beta-activity, the old state of things being gradually returned to on recooling. In any case there now can be no doubt that radioactive equilibrium, as well as chemical equilibrium, is effected by temperature; but the amount of dependence upon temperature is of very different degree in the two cases.

Refractivities of Vapours.

Mr. E. B. R. Prideaux recently succeeded in producing hexafluorides of sulphur, selenium, and tellurium, and has investigated their properties. Their refractivities were determined for him by Messrs. Cuthbertson and Metcalfe by means of an interference method. The interest of the results arises in connection with the possibility of calculating the refractivity of a compound from the values for its constituents by simple addition. It is found that for this series of similar compounds there is no approach to an addition law. The values of the refractivities determined are in the proportion of 783, 895, and 991 on the same scale as that for which the value for an atom of fluorine is 96, of sulphur 540, of selenium 810, of tellurium 1350. The values calculated from the addition law for the three compounds are 1116, 1386, and 1926 respectively; comparison of these with the experimental values shows very marked divergence. The experimental values, on the other hand, are connected with one another by a linear law; that is to say, if these values are plotted against the densities of the vapours to which they relate, the points obtained lie in a straight line. This is the first series that has been examined in this way.

National Physical Laboratory Researches.

Amongst the numerous researches which have been carried out during the past year, we notice a redetermination of the melting point of platinum by Dr. Harker, which is now found to be 1710° C. within five degrees. Some experiments by Holborn and Henning at the Reichanstalt, published in 1905, give the figure 1710° C. also. Thus it seems clear that the value 1780 usually accepted is 70 degrees too high.

An important series of determinations of the calorimetric properties of steam is being made by Mr. Jakeman. After overcoming difficulties mainly concerned with the efficient control of the radiation, he has succeeded in obtaining the specific heat of steam at 4·3 atmospheres pressure, and temperatures ranging from 30 degrees C. to 130 degrees C. above saturation. He hopes now to go on to other pressures and temperatures. The Committee are indebted to the Manchester Steam Users' Association for funds to help with this work.

ZOOLOGICAL.

By R. LYDEKKER.

Hairs in Amber.

THE insects preserved in amber have long since been carefully studied and described, with the result that in most cases they have been found to approximate very closely to living types. A new feature is, however, the discovery of hairs of mammals in this fossil resin which have recently engaged the attention of a German naturalist. So far as can be determined, such hairs as have at present been examined appear to belong to dormouse-like rodents, although, as it has not yet been found possible to identify them with those of any known genus, it has been suggested that they indicate an extinct ancestral type. Assuming their describer to be right in this view, it is satisfactory to find that he has not considered it necessary to give to the hypothetical rodent thus indicated a distinct name; and it is much to be hoped that the same course will be followed by his successor in this line of research. For if dormice or other mammals were named on the evidence of their fossilised hairs, there would be no possibility of correlating species thus named with those founded upon the evidence of bones or teeth, with the result that zoological nomenclature would become still further involved without any compensating advantage.

Flying Snakes.

Although the alleged flying powers of certain Malay frogs is now generally considered to be a myth, according to Mr. R. Shelford, who recently read a note on the subject before the London Zoological Society, three tree-snakes from Borneo are stated by the natives (and native testimony has, very generally at least, a foundation of truth) to be possessed of the power of taking flying leaps from the boughs of trees to the ground. The snakes in question, which belong to two distinct groups, are respectively named *Chrysopelea ornata*, *C. chrysochlora*, and *Dendrophis pictus*. In all three of these, the scales on the lower surface of the body are provided with a suture or hinge-line on each side; and by means of a muscular contraction these scales can be drawn inwards, so that the whole lower surface becomes quite concave and the snake itself may be compared to a rod of bamboo bisected longitudinally. By experiments on *C. ornata* it was seen that the snake when falling from a height descended not in writhing coils, but with the body held stiff and rigid, and that the line of the fall was at an angle to a straight line from the point of departure to the ground. In the author's opinion it is highly probable that the concave ventral surface of the snake helps to buoy it up in its fall; as it can be shown that a longitudinally bisected rod of bamboo falls more slowly than an undivided rod of equal weight.

The Largest Frog.

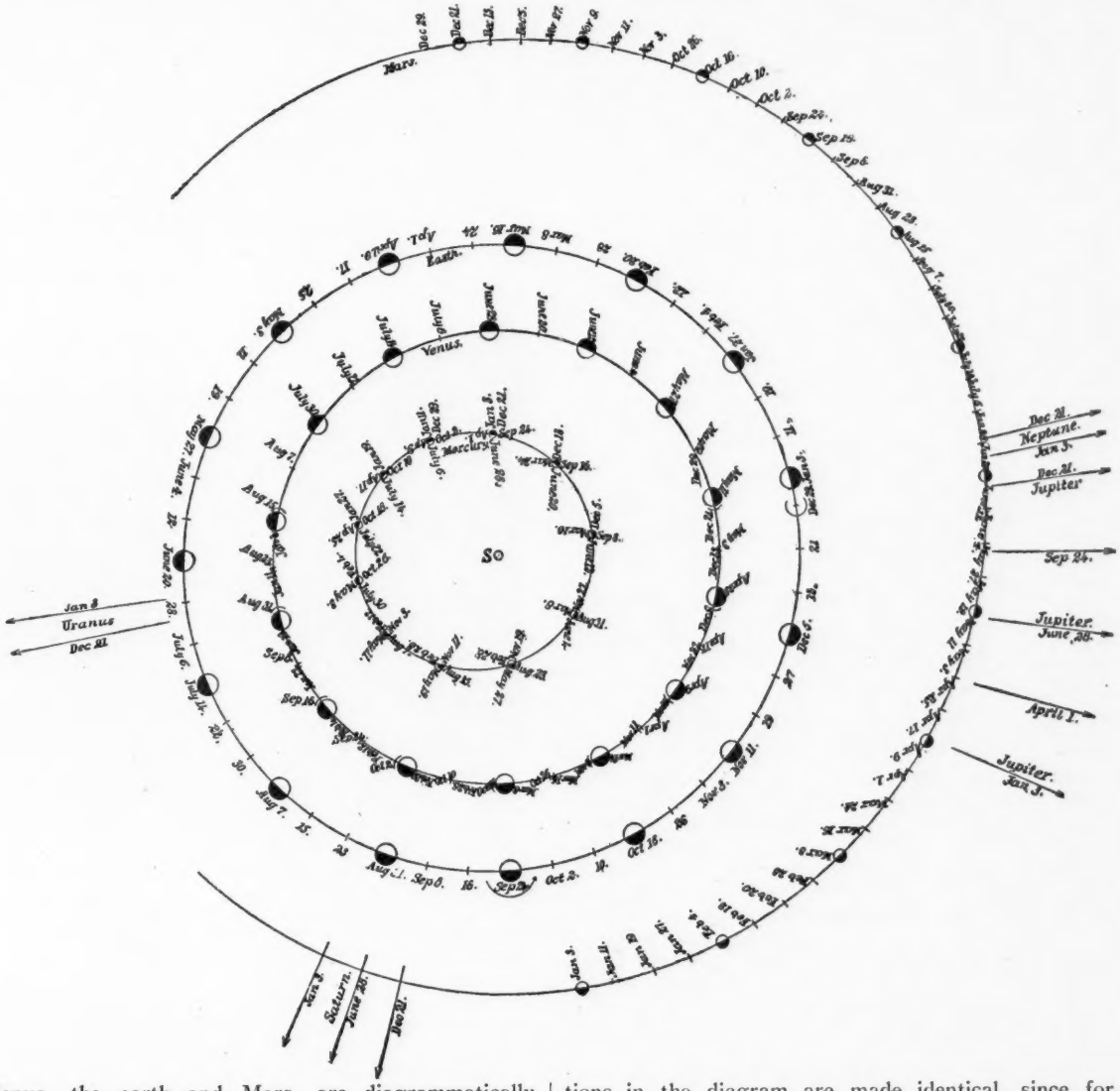
Hitherto the "record" in the matter of size, so far as frogs are concerned, has been held by *Rana guppyi*, a species discovered by Dr. Guppy in the Solomon Islands. The record is, however, now claimed for a species from the Cameroons which has been named *Rana goliath*, whose head and body measure no less than ten inches.

Revival of an Obsolete Name.

Another instance of a perfectly unnecessary attempt to disturb a generally accepted and well-known name is afforded by the proposal that the Japanese deer should be known as *Cervus nipon* in place of *Cervus sica*. It appears that the naturalist, Temminck, gave both names, replacing the first by the second, as being more appropriate. Although such changes would not now be tolerated, it was a common practice among the earlier naturalists, who thought themselves fully justified in so doing. And if this was the opinion and practice at the time, what is our justification for saying that it is illegitimate?

Morning and Evening Stars in 1906.

THE accompanying diagram is designed to aid in the identification of the planets which rise and set before the sun during the present year. The orbits of Mercury, Venus, the earth and Mars, are diagrammatically plotted so as to show the positions of each of these planets at intervals of eight days. The orbits of Jupiter, Saturn, Uranus, and Neptune fall beyond the limits of the page; but since the motions of the last three are limited to very small angular measurements, and that of Jupiter is not more than about one-twelfth of a revolution, the reader will be able, with the assistance of the drawing, to determine approximately the position in the heavens of each of these planets at any assigned date.



Mercury's position is first shown for January 3, and thereafter at intervals of eight days. As this planet's journey round the sun occupies 87 days and $23\frac{1}{4}$ hours, it reaches its first position again, approximately, on April 1, June 28, September 24, and December 21. Since Mercury's revolutions occupy slightly less than 88 days, therefore after four revolutions and a small fraction (352 days), the planet will reach a position which is about half a degree in advance of that occupied on January 3. But to avoid confusion the positions in the diagram are made identical, since for practical purposes the position is sufficiently accurate.

Venus performs her revolution in 224 days $16\frac{3}{4}$ hours; and in the case of this planet, and for the purposes of the diagram, 224 days is regarded as being the interval which will bring the planet to its first position of January 3. Subsequent positions are shown at intervals of eight days, because, by their selection, they may be compared with the positions of Mercury, the earth, or Mars on the same dates. Venus makes about $1\frac{5}{8}$ revolutions in our year; and her second revolution begins

on August 15. She is then represented on the diagram by the open circle which falls a little behind that of January 3, and is thereafter represented in a similar manner with the new date attached.

The earth and Mars are also shown at eight-day intervals after January 3. Jupiter's position on January 3 is on the line drawn from S. (the sun); and this planet reaches the positions indicated on April 1, June 28, September 24, and December 21. Similarly Saturn's position is shown for January 3, June 28, and December 21; and the directions of Uranus and Neptune are indicated for January 3 and December 21.

In order to determine the planets which rise before the sun, the reader must bear in mind that the earth revolves on its axis in the direction represented by the arrow (shown at the date September 24). At sunrise the observer emerges from the shadow area. If the drawing be held in such a position that the earth is between the reader and the sun, and he can read the date without turning his head, he will have a correct exhibit of the relative positions of the sun and planets at that date. In this position, if a planet is on the right of the sun, it evidently rises before him. Should the planet be exactly in line with the earth and sun, as, *e.g.*, in the case of Mercury or Venus, if the planet is on the near side, it is in inferior conjunction; if it is on the far side, it is in superior conjunction. If it is at or near conjunction, it will be lost in the sun's rays. At sunset the observer is entering the shadow area. When the drawing is held for a given date in the position above described, if the planet is on the left of the sun, it will set after him. In order to familiarise himself with the use of the plot, the reader is recommended to confine his attention to one planet at a time, and trace its movements relative to the earth and sun throughout the year. For example, if he will revolve the drawing until the earth is between him and the sun for the date January 3, he will read the same date attached to Mercury. Being on the right of the sun, he rises before him. If the drawing be revolved until the date February 20 is reached, Mercury will then be on the far side of the sun, *i.e.*, in superior conjunction. For some time prior to and after this date, the planet will be lost in the sun's rays. After this he will be on the left side of the sun, and will, therefore, set after him. He will be in conjunction—alternately superior and inferior—six times during the year on the following days:—February 20, April 5, June 8, August 12, September 24, and November 30. If the earth were stationary there would be twice as many conjunctions as revolutions, *i.e.*, eight; but this number is reduced by two on account of the revolutions of the earth around the sun.

Mercury will be seen to good advantage after May 3, before sunrise when near aphelion. He will also be seen advantageously in the early evening after June 28, when approaching aphelion. The last position indicated is December 29, when Mercury will rise before the sun.

Venus rises a short time before the sun on January 3, and thereafter. She will very slowly approach superior conjunction, which she will reach on February 14. She will be seen satisfactorily in the evening about the middle of June. Venus will then approach nearer the earth until November 30, when she will be in inferior conjunction. Her dark side will be presented to the earth, and she will be lost in the sun's rays. She will then rise before the sun until the end of the year.

Mars will be visible in the evening before July 15, when he will reach conjunction; and will then rise before the sun for the remainder of the year.

A New Edition of White's Selborne.

By EDWARD A. MARTIN, F.G.S., author of "A Bibliography of Gilbert White."

GILBERT WHITE'S book, of which a new edition is before us, was published in 1789. Shortly after publication the following remark was made to a nephew of White by Dr. Scrope Beardmore, the Warden of Merton College: "Your uncle has sent into the world a publication with nothing to call attention to it but an advertisement or two in the newspapers, but depend upon it the time will come when very few who buy books will be without it." This prediction has been wonderfully fulfilled, and in the hundred and seventeen years which have since elapsed there has been an average of one new edition in nearly every year.

The new edition which Mr. Charles Morley has

Selborne: View from the Hanger. The tower of the church and the roof of Gilbert White's house immediately in front of it, are just visible.

arranged is called a "naturalist's edition," and from the point of view of the modern systematic naturalist the new arrangement which he has adopted is undoubtedly justified. The whole of White's book has been cut up and classified under headings such as "Meteorology," "Insects," "Birds," &c. Perhaps I may be pardoned remarking that the idea occurred to me some years ago, but I abandoned it as likely to result in a book quite out of keeping with the spirit of White's work. One cannot deny that White was here and there guilty of inaccuracy, or that his conclusions were sometimes at fault, and for these very reasons each succeeding naturalist who edited the book found it necessary to add annotations correcting where it was necessary. Yet in spite of the fact that editors found this necessary, even in some cases adding notes which, in extent, were at greater length than White's own re-

The Natural History of Selborne, by Gilbert White. Naturalist's Edition, classified by Charles Morley. Pages 259, and Index. 6s. net. Elliot Stock.

marks, the popularity of the work has never waned. If it were merely in respect of its value as a natural history work that it has attained and maintained its high classic status, then we should expect at least to find greater accuracy and greater systematisation in it. Pennant, one of his correspondents, issued valuable natural history works, but these have been quite superseded by more modern works. Why, then, this phenomenal success of White's "Selborne"? Certainly not as a natural history book, although in the condition of nature knowledge at the time of publication that may have been then its chief attraction. There is something more in it than mere natural history, and it is this—the soul of the work—which, in the present edition, has perforce been left out of account. We do not recognise White in this re-arrangement. The same feelings do not inspire one in reading this edition. Of necessity the blending of one paragraph into another is absent. There is a disjointedness which grates on one's feelings when one has the original in one's mind. So it has been called wisely, as I think, the naturalist's edition, although I fear even naturalists will feel that certain explanatory or amending notes would have made it more readable and reliable.

Leaving aside, however, White's own personality and the charm of the connected series of letters, there are certain advantages in this re-arrangement which one would not wish to overlook. It was somewhat daring of Mr. Morley to cut up a classic work as he has, but at the same time the result will be extremely useful to those who, having an edition at hand with the arrangement of the letters as in the book when it left White's hands, desire to know all that the author had to say on some given topic. We have all wasted a good deal of time when wishing to look up some particular passage of White's in not being certain in which letter to find it. In this edition not only are kindred passages brought together, but the marginal references indicate the numbers of the letters of which they formed portions.

Cottages in Selborne Street, raised above the level of the road, which has been lowered by the "fretting down of ages," as in the case of many of the hollow lanes around.

There has been difficulty in allocating certain passages to the headings provided for the chapters. This is referred to in the author's preface, and is clear on perusing the book. Probably no one's arrangement would agree with that of another. But one would think that the references to the formation of the chalk downs should have been placed with the geological notes, as also those dealing with the theory of an isthmus across the Atlantic, upon which White pours so much scorn. Why, also, is the reference to the letters in which are printed White's monographs on the *Hirundines*, which formerly appeared in the "Philosophical Transactions," not placed under the heading of "Birds?"

One point which is brought out strongly by this edition is that White was before all things a student of birds. Although the extracts run only into 259 pages in all, no less than 134 pages are given to birds, the subject most nearly approaching to it in extent being meteorology, which claims but 30 pages, after which come the mammals, with 21 pages. Botany has 10 pages, but three of these are scarcely botanical, as they deal with what White calls a matter of domestic economy, namely, the use of rushes for making rushlights, and how the housewives who were careful eked out their scanty incomes.

The only other re-arrangement of the letters which has hitherto been attempted is that which was first accomplished by Sir William Jardine in 1833, in whose edition both series of letters are classified according to date, those to Pennant being interposed amongst others of similar dates to Barrington. This arrangement of the letters was followed in later editions by Captain Thomas Brown in 1833, and Edward Jesse in 1851, but Jardine in 1853 reverted to the original arrangement of the letters. Buckland, however, in 1875 adopted the chronological arrangement of the letters. Now we have a fresh classification under subject headings. It fills a vacant space, and all lovers of Gilbert White will no doubt make an acquaintance with it. It will remain a companion rather than a substitute for the older and original arrangement.

Artificial Rubies.

THE synthetic diamond is so small and the expense of making it comparatively so great that it is not likely to compete with the crystal made in Nature's laboratories. That is not quite true, however, of the artificial ruby, which can now be made of a "commercial" size, though examination under a lens will usually reveal its inferiority to the real article. Small crystals of a silicate of alumina coloured by bichromate of potash have been made for the last 15 years, and a method has been found of increasing their size by "nursing" them, or, in other words, by keeping the crystal in the mother liquid till it grows larger by aggregation. The small ruby to be "nursed" is placed on a turning-plate, where by means of an oxy-hydrogen blowpipe it is raised to a temperature of about 1,800 deg. Centigrade. Then with a pair of pincers there are added to it successively tiny grains of artificial ruby. If the work is carried on uninterruptedly without losing sight of the crystal dexterous handling makes it easy to get fine crystals, all of whose parts, though not of homogeneous origin, are melted together and recrystalised into a single form, which may be cut like a natural crystal. One of the difficulties of the work is that the crystals often break while cooling, and one of the defects of these manufactured crystals is the presence of air bubbles which can be detected by a microscope.

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REVIEWS OF BOOKS.

ASTRONOMY.

"Der Bau des Fixsternsystems" (The Structure of the Stellar Universe, with Special Reference to Photometric Results), by Dr. Hermann Kobold, Braunschweig. F. Vieweg and Sohn; 6m. 50., pp. xi. + 256, with 3 plates and 19 figures in the text).—This is Vol. XI. of the "Wissenschaft" series of monographs on natural science and mathematics, and must not be regarded as a work of imaginative philosophy. It is an exhaustive collection of methods and results connected with the subject of stellar and solar motion, by no means confined to the photometry emphasised in the title. This is fortunate, for the underlying assumption in the ordinary photometric method is that brightness and distance are in something like inverse ratio as a rule, and to this the known exceptions are so numerous as to throw great suspicion on the method. Some forty pages are devoted to instruments and methods of observation, the determination of positions, brightness, colour, spectral type, parallax, proper motion, radial velocity, and distribution of stars, with different light-scales, colour-scales, and spectrum classification, very little being omitted. Then come about 120 pages of separate results, similarly divided and equally complete, from Ptolemy and Al Sufi to the twentieth century, with photometric comparison of catalogues, distribution of spectral types, a very interesting table of 43 stars, with parallax greater than 1-20th of a second of arc, giving their computed absolute brightness on a scale in which Sirius is represented by 1000, the sun by 34, Vega and Capella by more than 4,000, and α Crucis by about 5,000, and a long section devoted to the solar motion, with a chart showing the results of more than a score of different determinations of the apex, including two by the author, the first of which has been shown to be quite unjustified, the second depending on determinations of radial velocity. It must be admitted that nearly all recent work on this subject emphasises the idea that although the solar system is almost certainly moving towards a point not very far from the direction of Vega, yet the actual result of investigation is far from satisfactory, inasmuch as each different set of stars gives a different position for the apex, *e.g.*, stars of type I. give a different result from stars of type II., bright stars a different result from faint stars, and so on; and although it would seem that stars of large proper motion, or large radial velocity should give a better result, since the effect of small systematic errors is relatively less in their case, yet the material of this character, being at present restricted in quantity, partly nullifies the advantage. Perhaps, when Herr Ristenpart's great catalogue is completed, a discussion of all available material may give a result that will inspire more confidence. The last sixty pages of the book are devoted to the "Bau des Fixternsystems," and special care, as usual, is taken to refer everything to the Milky Way, as the basis of the most obvious and plausible hypotheses. Some good illustrations of the nebulæ are given in this connection, especially a fine copy of Wolf's photograph of the "America" nebula in Cygnus, which figures as frontispiece to the book. At the end we find useful tables, one of 56 stars with well-determined parallax, principally from the work of Gill, Elkin, and Peter, giving the classification according to Pickering and Vogel, and in some cases the radial velocity, and the other of 307 stars with proper motion greater than half a second of arc; which is Porter's list of 301 stars (Cincinnati, Publication No. 14), but corrected and revised, with the addition of six more recent discoveries, including the great southern "runaway," Cardoba, Zone V., 243. Then follow a short bibliography, a useful index, and two large charts of the position of the North and South Poles of the proper motions of the 307 stars in the list. As a monograph on the subject, the work is excellent, but no one need adopt any hasty conclusions from the wealth of material.

"A la poursuite d'une ombre." Travaux et Observations de la Société Astronomique Flammarion de Montpellier. Eclipse totale de Soleil du 30 Aout, 1905.—A young Society, founded only in 1902, with an annual subscription of five shillings (six francs), has been able to send an expedition of ten members to observe the total eclipse of 1905 August 30, at Alcala de Chisvert; a book of nearly a hundred pages embodies the result in the form of chatty reports by Professor Marcel Moye, of Montpellier University, one of the secretaries of the Society. Their equipment, as was natural, was far from elaborate, but from the many lines of eclipse work that do not require such equipment, this Society omitted very few, as they carried out on a small scale the careful division of labour now generally associated with a naval detachment under the direction of Sir Norman Lockyer. In view of the forthcoming volume from the British Astronomical Association, dealing with the same eclipse, we need not look for anything of unique value in the Montpellier results, and the drawings, as reproduced in the work, have a harsh effect, owing to the too great contrast with the background, suffering much in comparison with Hansky's 1896 eclipse photograph, also reproduced in the volume. But as evidence of vitality and enthusiasm in a scientific society, we have nothing but praise for the book.

BOTANY.

The Book of the Rothamsted Experiments, by A. D. Hall, M.A. (John Murray; 10s. 6d. net.)—To every student of agriculture, irrespective of nationality, the mention of Rothamsted recalls to mind the most extended and varied series of experiments, bearing on every branch of agriculture, that has hitherto been, or probably ever will be, attempted. Furthermore, the immense amount of information presented in a concise and methodical manner, representing continuous research extended for over half a century, and presented to the world at large, will for all time serve as a model, and furnish a sound starting-point for future investigators.

The primary object of the book under consideration is to present to the student the chief points of importance, and generalisations suggested by the investigations alluded to; also to indicate the scope and aim of the Rothamsted Experiment Station. The result is an unqualified success. There is nothing in the book that cannot be grasped by the farmer or horticulturist taking an intelligent interest in his vocation, whereas to the student and expert its pages teem with valuable first-hand information, and suggestions for future investigation.

The entire work is founded on a strictly scientific basis, and deals only with fundamental problems, as indicated by the following extract from the preface: "The farmer who visits Rothamsted must not expect to see demonstrations of the most profitable means of growing this or that crop, but rather to obtain information as to its habits or requirements, which on reflection he can make useful under his own conditions."

Of exceeding interest is the chapter on the sources of the nitrogen of vegetation; the researches on this subject conducted by Lawes and Gilbert resulted in clearly demonstrating that the above-ground green parts of plants did not possess the power of fixing nitrogen; on the other hand these experimenters failed to demonstrate the fact that free nitrogen was fixed by bacteria present in the nodules on the roots of leguminous plants. This, however, was not so much due to the fault of the investigators concerned, as to the general apathy towards scientific research in this country. If the necessary knowledge had been forthcoming it would have been utilized. This gap, bearing on bacteriological work has, so far as Rothamsted is concerned, been bridged by the present Director.

The generally accepted idea that whole meal of wheat grain is the most nutritive food is fully dealt with, and shown to be wrong.

From scattered remarks it is gathered that an excess of nitrogenous manure favours the attack of fungus parasites.

A very interesting biographical sketch of Sir John Bennet Lawes and Sir Joseph Henry Gilbert, the founders of the Rothamsted Station, is given.

CHEMISTRY.

Qualitative Chemical Analysis (Organic and Inorganic), by F. Mollwo Perkin, Ph.D. (Longmans, Green & Co.; vi. + 308 pp., 5½ + 8½, 4s., 1905).—The author, who recognises the fact so familiar to teachers of chemistry that students too often

completely separate their theoretical knowledge from their laboratory experience, has endeavoured in this manual of qualitative chemical analysis to supplement the practical instructions by sufficient explanatory data to arouse in the learner an intelligent interest in the operations under discussion. In these theoretical explanations the author has made judicious use of the ionic theory, employing it where the earlier views are incomplete or misleading, but retaining the older mode of representing double decompositions when this formulation indicates with sufficient accuracy the reactions taking place in the various analytical tests. The chapter on reactions in solutions and the paragraph relating to the solubility of magnesium hydroxide in ammonium chloride are cases in point. The inorganic section of the book deals very fully with the reactions of the ordinary metals and acids and contains also the distinctive tests of certain rarer metals and less common acids. The author states in the prefaces to both editions of the work that only those reactions are included which have been experimentally verified. At the risk of adding to this practical revision, we venture to suggest a few instances in which a little additional information might be imparted without materially increasing the size of the volume.

Among the tests for bismuth no mention is made of the action of reducing agents; the interaction with alkaline stannites is, however, of some interest, having been recently the subject of a controversy concerning the alleged existence of bismuth suboxide.

The statement on p.69 that "the solutions [of chromium salts] are violet or green depending on their concentration" does not sufficiently take into account the effect of temperature on the colour and constitution of these dissolved salts, and of the tendency for the cation Cr to form complex ions with certain anions, such as SO_4 for example.

Our experience is that the separation of the sulphides of manganese and zinc from those of nickel and cobalt by means of cold dilute hydrochloric acid is not always reliable, and hence it might be well to give at least a brief reference to the alternative method in which the four sulphides are dissolved simultaneously, the separation being then effected by successive treatment with caustic soda, hydrochloric acid, ammonium acetate, and sulphuretted hydrogen.

The acidified permanganate process for detecting chlorides in presence of bromides and iodides is a useful alternative method to those indicated in the text, and the only distinctive test given for bicarbonates might be supplemented by a reference to the behaviour of these substances towards phenolphthalein or mercuric chloride.

The organic section contains a useful chapter on "elementary" organic analysis in which a note should be introduced pointing out the danger of employing the sodium or potassium test for nitrogen with nitro-compounds of the picric acid type. The remaining chapters deal with the reactions of representative examples of the chief groups of organic derivatives. The sections on alkaloids, carbohydrates, and organic acids merit special mention as the range of examples is very extensive, and many quite modern tests have been incorporated. Whenever possible, these organic reactions have been tabulated, a system which facilitates comparison and tends to render the practical work more systematic.

Full particulars for the preparation of the reagents required in both inorganic and organic sections are given in the appendix.

Although a few trivial clerical errors still persist (*e.g.* pp. 184, 210), the present edition bears the marks of careful revision, and the author is to be congratulated on the large amount of useful information which he has condensed into a convenient bulk. On this account the work may be regarded not only as an up-to-date laboratory manual, but also as a serviceable book of reference on analytical chemistry.

ETHNOLOGY.

The Twenty-Third Annual Report of the Bureau of American Ethnology (Government Printing Office, Washington).—When we take up a large and handsome volume of over 600 pages and find that, in addition to many smaller illustrations, there are no less than 139 excellent plates, mostly coloured, within it, we can but wonder whether so splendid a work is worth all the trouble bestowed upon it. This, of course, entirely depends upon the subject, which in this case is confined to an account of one tribe of American Indians. The Zuni Indians: Their Mythology, Esoteric Fraternities, and Ceremonies, are described in the fullest detail by Mrs. M. C. Stevenson. This tribe inhabits districts in New Mexico and Arizona and is one of great interest. "They look to their gods for nourishment and for all things pertaining to their welfare in this world, and while the woof of their religion is coloured with poetic conceptions, when the fabric is separated threat by thread we find the web composed of a few simple, practical concepts." The expedition sent by the Bureau of Ethnology in 1879 to study this district remained at Zuni for six months, and in subsequent years returned again for long periods, so that the work has been very thoroughly accomplished, and apart from the interest of the peculiarities of the tribe, it is a pleasure to see any one subject so exhaustively treated of, and all interested in ethnology and the quaint habits of wild people will welcome this great work with delight.

NATURAL HISTORY.

Our School Out of Doors.—A Nature book for young people. By the Hon. M. Cordelia Leigh (T. Fisher Unwin; 2s.). This is a most excellent little guide to everyday knowledge. The various subjects dealt with are included in short paragraphs with clear headings, and a set of questions ends up each chapter, ensuring a mastery of its lessons. A number of good illustrations add to the attractiveness of this practical little book.

SCHOLASTIC.

Elements of Descriptive Geometry, by O. E. Randall, Ph.D. (Ginn and Co., New York; pp. 209).—This is a treatise on geometrical drawing, or practical solid geometry, dealing with the projection not only of rectilinear solids, but also of curves and surfaces of single and double curvature. It is intended primarily for students of engineering drawing, for whom it is well suited.

English Composition Simplified, by J. Logan (T. Murby and Co.; 1s. 6d.). Those who wish to have on their table a concise and practical guide to English composition cannot do better than procure this little work, which in unpretentious fashion gives all the more recognised rules connected with it. Nearly half the work, however, is devoted to skeleton and specimen essays, which do not seem, to our thinking, to be of any great practical value.

SOCIOLOGY.

Foundations of Political Economy, by William Bell Robertson (Walter Scott Publishing Co.; 5s.). This work has two aims in view, the one being, we think, rather difficult to reconcile with the other. These are to maintain a "strict adherence to the methods of . . . the orthodox school" in the treatment of political economy, while the other is "to sever from any future connection with it the epithet 'dismal.'" Though we cannot say that the work has caused us any great hilarity, the subject treated of is put clearly and to the point.

MISCELLANEOUS.

Mrs. Beeton's Book of Household Management (Ward Lock and Co.). New edition. This, though hardly to be classed under the heading of scientific works, is thoroughly deserving of notice as a most complete guide to all that pertains to the culinary laboratory. The various methods of analysis incidental to the preparation of bodily nutriments, and the observation of the reactions occurring in the cooking pot are, after all, some of the most important investigations in human life and happiness, and this very complete work should certainly be in the possession of all who take a pride and an interest in their internal mechanism.

Sundials.—Messrs. Newton and Co. issue a special catalogue of sundials and pedestals, which they make in every variety, and to suit every position. The sundial has of late years enjoyed a renaissance of popularity, due, no doubt, to the reviving interest in every kind of antique property, from Tudor manor houses to Adams' mantelpieces; and sundials are not the least charming objects of an admirable taste. Those which Messrs. Newton advertise are excellent in execution and design; they enshrine all the old mottoes from "Light rules me, the shadow thee," to the didactic, "Sic Vita, Finis Ita," on old Chelsea Church. Their workmanship, pattern, and design are alike unexceptionable.

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MICROSCOPY

Conducted by F. SHILLINGTON SCALES, B.A., F.R.M.S.

Elementary Photo-micrography.

(*Continued from page* 416.)

I HAVE now dealt at some length with the camera and the adjustment of the microscope, and it only remains to add a few words on the photographic process itself. I shall assume that the reader has some experience of ordinary photography, and shall content myself, therefore, with explaining such modifications as are necessary for photo-micrography. Formerly an initial difficulty made itself felt owing to the difference in focus between the visual and actinic rays of an objective, by which I mean that though an object might appear to be in focus on the ground-glass or plate-glass screens when examined visually, the photographic negative when developed was found to be out of focus owing to the fact that the actinic rays were not identical with the visual rays. Owing to the improvement in objectives, however, by which they tend towards apochromatism, and to the use of orthochromatic plates and certain screens, this difficulty seldom occurs now. Therefore possessors of modern objectives will have little trouble on this score, and such objectives may be used either with or without an eye-piece, but in the former case a projection ocular should be obtained, and will give better results. Huyghenian oculars do not perform well in photography. Apochromats cannot be used alone, but perform excellently with their compensating oculars as well as with projection oculars.

There comes in, however, another difficulty. Unless an object has good contrast it is manifest that the resulting photograph will be lacking also in contrast, but what is less evident is that the stains with which microscopical slides are stained may differentiate structure sharply enough to the eye, and yet, owing to the varying actinicity of the colours, fail to differentiate the same structure satisfactorily in the photograph. An ordinary photographic plate, for instance, shows a great susceptibility to the rays at the violet and blue end of the spectrum, and very little to those at the yellow and red end.

If the object were merely black and white this would not be material, but supposing we were trying to photograph a violet or blue object on a yellow ground we should find that the object would impress itself upon the plate as fast as the ground, and there would be no contrast or differentiation. We should, therefore, need to keep back the violet of the object and to assist the yellow of the ground. Our first method of dealing with this is to use an orthochromatic plate, namely, one made either actually or comparatively more sensitive to yellow, and our second method is to use a screen, in this case a piece of dense yellow glass, which will cut off, or, at least, keep back, the violet rays, and so assist the yellow rays to impress themselves upon the yellow sensitive plate. Of course, the treatment will be varied according to the staining, and it might even happen that with a pale yellow object we might need to use an ordinary plate and a blue or green screen, but enough has been said to show the nature of the difficulties besetting the photo-micrographer, and the way to deal with them. Generally speaking, the principle is to keep back the colour with which an object is stained by using a plate which is not sensitive to that colour, and a screen (generally of an opposite colour) which tends to nullify it.

(*To be continued.*)

Royal Microscopical Society.

At the meeting held on March 21, the Rt. Hon. Sir Ford North, P.C., F.R.S., Vice-President, in the chair, the death of Mr. J. J. Vezey, Treasurer of the Society, was announced. Mr. Wynne E. Baxter, J.P., F.G.S., was appointed Treasurer in succession to Mr. Vezey. Mr. J. W. Gordon exhibited and described a new retro-ocular or top-stop for obtaining dark ground illumination with high-power objectives, and increasing the definition of highly-resolved images in a bright field. Mr. C. F. Rousselet read a paper entitled "A Contribution to our Knowledge of the Rotifera of South Africa," illustrated with lantern slides and mounted specimens. Mr. J. M. Coon exhibited and described a new form of finder, which could be used on any microscope, and with high powers, and by which the object registered on one microscope could be found on any other. The Secretary read an abstract of a paper by Mr. N. D. F. Pearce "On some Oribatidæ from Sikkim." A paper by Mr. E. M. Nelson "On the Limits of Resolving Power for the Microscope and Telescope," being of a technical character, was taken as read.

Quekett Microscopical Club.

At the meeting held on March 16, Mr. C. D. Soar, F.R.M.S., gave a lecture on "The Life-History of Fresh-water Mites (*Hydrachnidæ*)." The life-history may be divided into four stages—ovum, larva, nymph, and adult. Descriptions were given of some of the various methods adopted by different species in depositing the eggs. The incubation period is about 30 days. The development of the embryo was described and illustrated by a series of figures drawn every two days from the deposition of the egg until the emergence of the larva. In the second stage of the life-history the larva usually becomes parasitic, as a rule selecting a host which lives in the water. The insects most commonly infested were mentioned, and several specimens from the genus *Dytiscus* were shown in spirit with a number of the larvæ attached like small bags to the ventral surface. *D. marginalis* was said to be a very favourite host. After describing the nymph stage, the lecturer showed by means of the lantern a number of interesting drawings of adult forms of some of the 60 genera at present known. The life-history of these mites was first described by Müller in 1834.

Mobile Crystallisation.

The *Times*, of January 3, quoting from the *Frankfurter Zeitung* of December 12, has an interesting and suggestive note on a new physical action which has recently been observed in the Physical Institute of the Karlsruhe Polytechnic, a fuller account of which was to appear in the *Annalen der Physik*. It was observed there some time ago that in certain kinds of solutions tending to form emulsions, the existence of extremely soft, almost liquid, crystals was possible, which, under certain conditions, assumed the forms characteristic of solid crystals, cubes, prisms, and the like. In other cases, for instance, when under the influence of protracted cooling, the cohesion, and with it the surface

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tension, became increased, these bodies might assume the forms of minute spherical drops, like those found in ordinary fluids. More recently, on microscopically examining certain of these drops, it was found that they behaved like living infusoria, and were in such active motion that the eye could scarcely follow them. The drops, which had somewhat the consistence of olive oil, were not absolutely spherical, but they frequently have a funicular depression from the middle of which a ray is directed to the centre of the drop. The drops change very suddenly in form, and assume a serpentine shape. In other cases they appear to bud out or become divided, and give rise to several new particles by a species of spontaneous self-division. The changes which take place are similar to those observed in the case of micro-organisms, but in this instance they are no doubt caused by very slight variations of temperature.

Messrs. Flatters and Garnett's Catalogue.

Messrs. Flatters and Garnett, of Manchester, have sent me a new catalogue which they have just issued. The first part contains a classified list of slides of their own mounting, the majority of which are sold at the very modest price of 6d. each. Amongst these I may mention their excellent Student's Series of Botanical Slides, 48 in all, sold at 21s. the set, or with an explanatory book of diagrams 1s. extra. The second part of the catalogue contains a list of microscopes and accessories by the leading English and Continental makers, and particulars of various mounting and other microscopical requisites. Apparatus for the study of pond-life is particularly well represented, and amongst this are various sizes of rectangular glass tanks, made in one piece, for use with hand lenses, and two neat japanned collecting cases containing corked tubes, so arranged that the tubes cannot be upset when the case is placed open upon the ground.

Microscopical Material.

By the kindness of Mr. J. Strachan, of Ballyclare, Co. Antrim, I am able to offer to such of my readers as care to apply for it some diatomaceous earth from the deposit at Toome, on the river Bann, Co. Antrim. Applications must be accompanied by the coupon to be found in the advertisement pages of this issue, together with a stamped and addressed envelope, and, preferably, by a very small box. It is, perhaps, advisable to mention that I not infrequently receive applications for similar material, which, in spite of clear instructions, are accompanied neither by envelope nor stamp, and to these I feel myself justified in paying no attention.

Notes and Queries.

C. T. D., Hayward's Heath.—A one-sixth inch objective will probably show you most of what you want to see with regard to animal hairs, and for this power a condenser is necessary if you wish the objective to perform at its best. The pigment granules can generally be seen if the hair is a transparent one, but if not you will need to cut longitudinal sections by means of some embedding process. I do not know of any work that has been done on the pigment granules themselves, but a book like Schäfer's "Essentials of Histology," describes human hairs and their follicles with some detail.

T. P. T., Aden.—To distinguish diatoms from Radiolaria, it would be necessary to see them in the living state, or to be sufficiently familiar with the frustule or silicious skeleton of the particular species. The Radiolaria have, for the most part, skeletons quite unlike the frustules of the diatoms, whilst the presence of pseudopodia in a living specimen would at once place it amongst the Rhizopoda. Haeckel's epoch-making work on the Radiolaria is, of course, authoritative, but the best work of reference is the great monograph in the "Challenger" Reports, which contains 1,800 pages and 140 plates, and describes nearly 4,500 species.

S. C. M., Bombay.—A one inch or two-thirds of an inch and a one-sixth of an inch objectives are quite sufficient to examine textile fibres either with or without reagents. An oil-immersion objective would not be suitable for examining micro-chemical reactions, but a one-eighth inch *dry* lens can be used for certain classes of work. I do not know of any "acid-proof" objectives for such work. Personally I keep three special and inexpensive objectives for this purpose, and when necessary affix a small piece of broken cover-glass with glycerine to the front lens, whilst the microscope has a special glass stage. I know of no differential stains for identifying fibres other than those mentioned in my article on the subject—fuchsine would merely stain the fibres and so help to bring out their structure. It is not necessary to fix the fibres to the slip before staining; they can be taken up on the point of a needle and transferred from stain to other reagents as desired and only teased out on the slip prior to mounting. I do not think it would be any use trying to cut sections of fibres unless you have any special reason for doing so, in which case a few fibres could be tied together longitudinally and supported in carrot, pith, or paraffin for transverse sectioning. Nor do I think it would be of service to try to cut sections of paper pulp—it would be a most unsatisfactory job at best, but of course if you wished to do so you could dehydrate in alcohol, clear in xylol and embed in paraffin, or you could embed in celloidin, or even freeze direct with ether.

C. J., Birmingham.—For the use of a polarizer and analyser in ordinary work not connected with the special study of crystallographic systems it is only necessary to have some means of knowing when the Nicol prisms are parallel or crossed, and for this purpose four marks or stops 90° apart are sufficient. It is certainly not necessary to get a polarizing prism large enough to cover the back lens of your condenser. Iceland spar is not only expensive, but the expense increases out of all proportion in the larger prisms. Such a prism would moreover necessarily have a most inconvenient length. I should recommend an ordinary polarizer costing about 20s. or 30s. (with removable selenite), and with a thread in the mount into which you can screw the optical part of your condenser so as to get more light if necessary. The analyser can be mounted either over the objective or over the eyepiece: the former is the cheaper but causes rather more loss of light; the latter is more effective and gives a larger field if of sufficient size. The prism should be removable from the eyepiece. I think you would find Watson's "Universal" Condenser more generally useful than their "Parachromatic," unless you work almost entirely with high powers.

J. B., Kelvinside.—I do not know of any advanced book which deals with pond and aquarium life and which would enable you to name objects. Such books are written for amateurs and are necessarily somewhat chatty and discursive. Taking Furneaux's book as a good example of such books, I should say that if you want more detail you must be prepared to study one or more special branches for yourself with the help of special works dealing with such branches; for example, one or more volumes of the Cambridge Natural History or of Prof. Ray Lankester's even more advanced "Treatise on Zoology." You will find the second volume of Carpenter's "The Microscope and its Revelations" of no little service to you in studying microscopic natural history, but I cannot say that it will help you to name many specimens. That, except for the commonest species, is work for specialists.

W. H. B., Leicester.—I am sorry that I cannot give you any information as to the mounting of diatoms in realgar. I have some specimens of *Amphipleura pellucida* mounted in this medium, but I believe they were done by one man, who is a professional mounter. Nor do I know of any solvent for realgar which does not decompose it, but it is supposed to fuse easily, and as diatoms will stand a good heat I should look upon this method as offering most probabilities of success. I should be grateful if any of my readers could give any information on the matter, as I have been asked this question before.

[*Communications and Enquiries on Microscopical matters should be addressed to F. Shillington Scales, "Jersey," St. Barnabas Road, Cambridge.*]

The Face of the Sky for May.

By W. SHACKLETON, F.R.A.S.

THE SUN.—On the 1st the Sun rises at 4.35 and sets at 7.20; on the 31st he rises at 3.52 and sets at 8.3.

Sunspots and faculæ are, at this period of solar activity, usually to be seen on the Sun's disc. Several large sunspots have of late been observable on the disc at the same time; prominences also have been conspicuous on the Sun's limb, as shown by spectroscopic observations.

The position of the Sun's axis, equator, and heliographic longitude of the centre of the disc is shown in the following table:—

Date.	Axis inclined from N. point.	Centre of disc S. of Sun's Equator.	Heliographic Longitude of Centre of Disc.
May 1 ..	24° 26′ W	4° 2′	133° 45′
,, 6 ..	23° 30′ W	3° 30′	67° 40′
,, 11 ..	22° 22′ W	2° 58′	1° 33′
,, 16 ..	21° 4′ W	2° 24′	295° 26′
,, 21 ..	19° 36′ W	1° 49′	229° 18′
,, 26 ..	17° 58′ W	1° 13′	163° 7′
,, 31 ..	16° 12′ W	0° 37′	96° 58′

THE MOON:—

Date.	Phases.	H. M.
May 1 ..	☽ First Quarter	7 7 p.m.
,, 8 ..	○ Full Moon	2 10 p.m.
,, 15 ..	☾ Last Quarter	7 3 a.m.
,, 23 ..	● New Moon	8 1 a.m.
,, 31 ..	☽ First Quarter	6 24 a.m.
,, 8 ..	Perigee	7 6 p.m.
,, 22 ..	Apogee	3 6 p.m.

OCCULTATIONS.—There are no naked eye stars occulted before midnight during this month; on the morning of the 6th at 1.33 a.m., however, there will be an interesting occultation of the double star γ Virginis.

THE PLANETS.—Mercury (May 1, R.A. $0^h\ 55^m$; Dec. N. 2° 47′. May 31, R.A. $3^h\ 48^m$; Dec. N. 19° 20′) is a morning star in Pisces and Aries. The planet is at greatest western elongation of 26° 46′ on the 3rd, when he rises about 4 a.m., or 33 minutes in advance of the Sun, hence the elongation is not a favourable one.

Venus (May 1, R.A. $3^h\ 48^m$; Dec. N. 20° 16′. May 31, R.A. $6^h\ 25^m$; Dec. N. 24° 45′) is an evening star in Taurus, setting about 9.45 p.m. on the 15th. The planet appears very bright in the N.W. portion of the evening sky and may be observed shortly after sunset; the disc is slightly gibbous and has an apparent diameter of 11″. On the evenings of the 11th and 12th the planet will be found in apparent proximity to Jupiter.

Mars (May 1, R.A. $3^h\ 59^m$; Dec. N. 21° 5′. May 31, R.A. $5^h\ 27^m$; Dec. N. 24° 0′) is an evening star in Taurus, setting about 9.20 p.m. throughout the month. The planet may be observed shortly after sunset looking to the north-west, but he does not appear very bright, and is not suited for observation in small telescopes as his apparent diameter is only 3″·8. On the evening of the 18th he appears in the sky about 1° north of Jupiter.

Jupiter (May 1, R.A. $4^h\ 32^m$; Dec. N. 21° 28′; May 31 R.A. $5^h\ 1^m$; Dec. N. 22° 22′) is only available for observation for a short time after sunset, and after this month will not again be observable as an evening star until September. The planet appears in too bright a part of the sky for the satellites to be easily observed.

During the early part of May the three most conspicuous planets will appear close together and near the 1st magnitude star Aldebaran (α Tauri), which, though not a matter of real astronomical interest, forms a rather unusual appearance in the evening sky. The diagram shows the positions on May 11, when the planets are all near together, Venus being the brightest and about 1° to the north of Jupiter whilst Mars is feebly visible about 3° away.

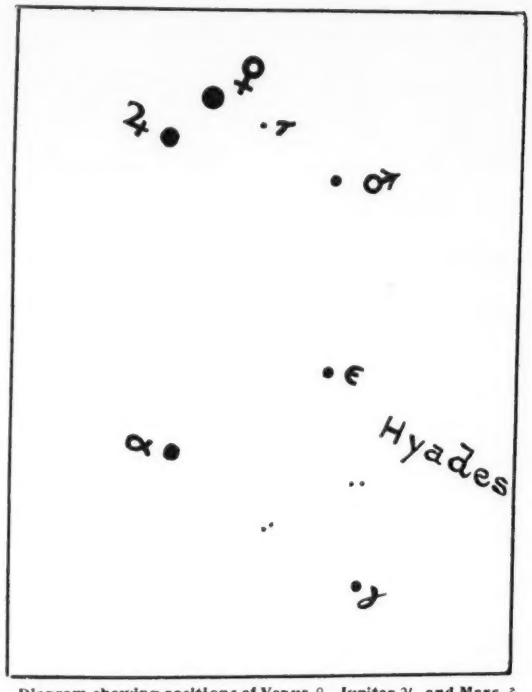

Diagram showing positions of Venus ♀, Jupiter ♃, and Mars ♂, on May 11.

The planets set about half past nine, and the moon, which is full on the 8th, will be rising in the east.

Saturn (May 1, R.A. $22^h\ 58^m$; Dec. S. 8° 23′. May 31, R.A. $23^h\ 6^m$; Dec. S. 7° 45′) is a morning star, rising about 2 a.m. near the middle of the month. The planet is situated in Aquarius.

Uranus (May 15, R.A. $18^h\ 35^m$; Dec. S. 23° 31′) rises about 11 p.m. near the middle of the month. The planet is badly placed for observation, as he is situated low down in Sagittarius.

Neptune (May 15, R.A. $6^h\ 37^m$; Dec. N. 22° 17′) is observable in the north-west portion of the evening sky during the early part of the month; on the 15th the planet sets about 11 p.m.

METEOR SHOWERS:—

The principal shower during May is the *Aquarids*. This may be looked for between May 1 to 6; the radiant being in R.A. $22^h\ 32^m$ Dec. S. 2°, near the star η Aquarii.

TELESCOPIC OBJECTS:—

DOUBLE STARS.— Libræ, XIV.^{h} 46^m, S. 15° 39′, mags. 3, 6; separation 230″; very wide pair.

σ Coronæ, XVI.^{h} 11^m, N. 34° 8′, mags. 6, 6½; separation 4″·6; binary.

α Herculis, XVII.^{h} 10^m, N. 14° 30′, mags. 2½, 6; separation 4″·6. Very pretty double, with good contrast of colours, the brighter component being orange, the other blue.

δ Herculis XVII.^{h} 11^m, N. 24° 57′, mags. 3, 8; separation 17″.

CLUSTERS.—M13 (cluster in Hercules) situated about ⅓ the distance from η to ζ Herculis, and is just visible to the naked eye. It is a globular cluster, and with a 3 or 4 inch telescope the outlying parts of the cluster can be resolved into a conglomeration of stars.